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COMBINED ARMS WARFARE-NEED FOR UNMANNED AERIAL SYSTEMS (UAS)?

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Abstract

The focus of the paper is to establish the strategic and operational necessity for the integral employment of UAS in combined arms warfare/operations. The aim is to reach that deduction providing theoretical precepts, elaborating on systems configurations onboard, as also actual application in recent wars. The types and technological upgrades in UAS have grown exponentially, and so have their multiple missions integral to combined arms warfare. They have proved substantially impactful both in the recent 2020 Azerbaijan-Armenia war and the ongoing Ukraine war. A detailed review of their role has been attempted. UAS can perform multi-domain tasks during peace and war, ranging from domain and battlefield awareness including maritime; expeditionary operations involving extended ranges; early warning; targeting for stand-off attacks; strike on numerous military and sensitive targets; electronic warfare; Information Influence Operations; sensitive reconnaissance operations; long-loiter reconnaissance activities; tactical ISR missions using multiple sensors in a single platform for multiple missions, and act as communication hubs for numerous platforms. All this without risk to life and limb, and without overextending the mental, psychological and physical capacity and capabilities of the human resource. UASs therefore are postured to serve as a lower-risk and highly adaptable link in combined arms warfare.

After due diligence and deliberation, I feel that almost all the roles and tasks discussed in the paper will be executed by Indian Armed Force (integral to combined arms warfare), PMF, intelligence agencies, ISRO, and even security agencies dealing with the economy (ED), and logistics, with minor modifications/change in profile, drills and payloads. We too will need UAS increasingly for multifarious tasks; collect and process vast amounts of information on adversary activities as part of balance-of-power competition: across a rich variety of terrain, space and water (Indian Ocean Region). India and our armed forces have been slow starters in incorporating UASs in multi-domain operations, but I am confident that with our historical entrepreneurship and innovative skills and perseverance, we will accelerate and level the playing field with our adversaries, specially China, which has now become a strategic imperative.

Multi-Domain Warfare (MDW): An Overview. The overlapping, progressive dimension of peace and war has moved to cooperation, competition, confrontation and conflict (4Cs) between nations; from individual military services (Army, Navy, Air Force, Amphibious Forces) to tri-Services operations, to combined arms warfare/operations, which apart from land, sea and air, includes kinetic domains of space and underwater, and non-kinetic/cognitive elements of cyber, digital, electro-magnetic spectrum and information operations; as also different types of warfare from conventional to urban, grey, counter insurgency and hybrid warfare. The spectre of a nuclear Armageddon has never been so probable. Since geo-strategic-political confrontation and conflict are both bilateral and multi-lateral, and involve nations, and not just military forces, MDW/O (Operations) to my mind, are more all-encompassing, involving combined arms warfare and the domains of politics, diplomatic, informational, military, economic (PDIME) domains. Most security especially military terminologies become ambiguous and overlapping with technological progress, inventions and innovations, hence the terms MDW and combined arms warfare are often used interchangeably. The emerging multi-polar world order is in continuous flux, with quickly changing alliances and groupings (specially security), forcing nations

into 24×7 engagement. Potential threats are multi-domain-directional, dispersed, manifest suddenly without warning, and difficult to discern from the routine state and institutional behaviour. There is a strategic necessity to make sense/analyse pattern of seemingly unconnected, disparate, activities, that may be a pointer to a competitor's broader pattern of hostile behaviour, and manifests across multiple regions and multiple operating domains. Hence, the Joint All-Domain Command and Control (JADC2) concept adopted by USA, and Chinese response with Multi-Domain Precision Warfare (MDPW),[1] and India optimising and synergising the NSCS (National Security Council Secretariat) with other Ministries, Armed Forces, intelligence agencies, cyber and data watch dogs, and remote sensing platforms and institutions. USA and China are monitoring events globally 24×7, while regional power India is just getting her act together to monitor and dominate her ever-increasing sphere of influence and interest; a separate subject altogether, but today the need for a separate Security Ministry including both interior and exterior needs study. The rapid, ubiquitous emergence of the UAS specially in the last five years, allows it to perform multi-domain-tasks in peace and war, cost effectively and with a much lower risk paradigm.

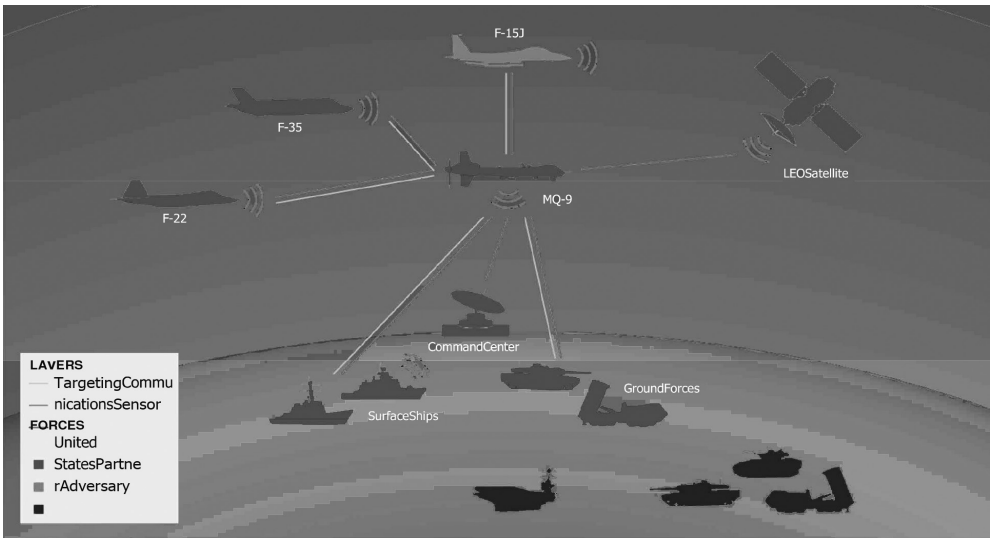
Combined Arms Warfare. Combined Arms warfare in the continental context are the appropriate combinations of infantry, mobile protected firepower, offensive and defensive fires, engineers, aviation (including UAS), logistics and joint capabilities. It is the application of these combinations in unified action that allows us to defeat enemy ground forces; to seize, occupy, and defend land areas; and to achieve physical, temporal, and psychological advantages over the enemy. By synchronizing combined arms and applying them simultaneously, commanders can achieve a greater effect than if each element was used separately or sequentially.[2] Combined arms capabilities are critical to success in battle, because no single arm can be decisive against a determined and adaptive enemy. Intelligence, surveillance and reconnaissance (ISR), Information Influence Operations (IIO) and data dominance has become vital for conduct of 4Cs and combined arms warfare, as it shapes the minds, and

thus behaviour of all actors of the adversary and own, including the leaders and citizens. It is important to highlight that non-kinetic/cognitive domains can cause physical destruction and causalities; rapid spreading of rumours leading to panic, paralysis and mob violence; jamming of international air and logistics circuits leading to accidents and mishaps.

UAS and Drones. The terms are used interchangeably. They are also called UAV (unmanned aerial vehicles) or pilotless aircraft. A drone/UAV is simply the aircraft or drone itself, while a UASs includes the entire system that supports and controls the drone; encompasses ground control stations, data links, and any other components like weapons, radars, jammers, cameras, communication equipment, required for the mission. The focus of this paper is on the strategic and operational necessity and employment of UAS in combined arms warfare/operations. The aim is to reach that deduction with both theoretical precepts, elaborating on system configurations onboard, as also actual application in recent wars. UAS have been playing an important role in warfare over the past three decades, mainly for counter terrorism operations, and ISR. There are two views about them amongst the experts; some feel that they have a caused a "revolution in military affairs (RMA),"which would eventually reshape military doctrine, organizations, force structure, operations, and tactics; others perceive the above attributed role as overstated, and they have limited utility in highly contested environments.

OVERVIEW OF EMPLOYING UAS, THEIR RISK AND ESCALATORY MATRIX IN COMBINED ARMY WARFARE

UAS are being employed for multiple tasks such as domain and battlefield awareness including maritime; expeditionary operations involving extended ranges (US operating in Africa, Afghanistan, Middle-East), early warning; targeting for stand-off attacks; strike on numerous military and sensitive targets including civilian infrastructure like power plants, generators as in Ukraine by the Russians; electronic warfare; IIO; sensitive reconnaissance operations; long-loiter reconnaissance activities; tactical ISR missions using multiple sensors in a single platform for multiple missions. Tasks could



Source: CSIS International Security Programme.

include imagery intelligence with full motion video; measurements and signals cum electronic intelligence; can collect and act as a communications hub for an integrated space, air, sea, or ground operations, while also ingesting, processing, and disseminating multiple streams of intelligence. Undoubtedly, mission flexibility is not unique to UASs. Several piloted aircraft are similarly multi-mission capable. But manned aircraft comes with risk of life and limb, and mental, psychological and physical capacity and capabilities of the human source. UASs therefore are postured to serve as a lower-risk and highly adaptable link in combined arms warfare. UAS generally present significantly lower operation and maintenance costs per flying hour than manned aircraft.[3] An important factor while tasking, is that the UAS comes lower in the escalation matrix of countries. In one 2015 example, Turkey shot down a Russian UAS that had entered its airspace, an act that did not provoke a reciprocal retaliation from Russia. One month later, Turkey shot down a manned Russian Su-24 attack aircraft, which precipitated a series of airstrikes against Turkish interests in Syria.[4] In 2019,

the Iranian military shot down an American RQ-4 Global Hawk while it was operating in international airspace over the Strait of Hormuz;[5] what followed was a warning statement issued by US Air Force Central Command. ISR by satellites maybe a better discreet, secure and secret option, however, if you want to signal interest or presence, UAS conveys it better. In the military domain, this signalling may include deploying assets to demonstrate presence and commitment. Examples include naval freedom of navigation operations (FONOPS) and airborne sensitive reconnaissance operations. It is in these latter operations where the employment of UASs can substantially expand a signaller's options and ability to manage escalation in times of crisis. A natural geo-political refrain would be "We are not going to war over a Predator.[6]" A scenario, incurring the loss of an unmanned aircraft and no human lives appears to introduce a range of credible response options beyond the military domain.

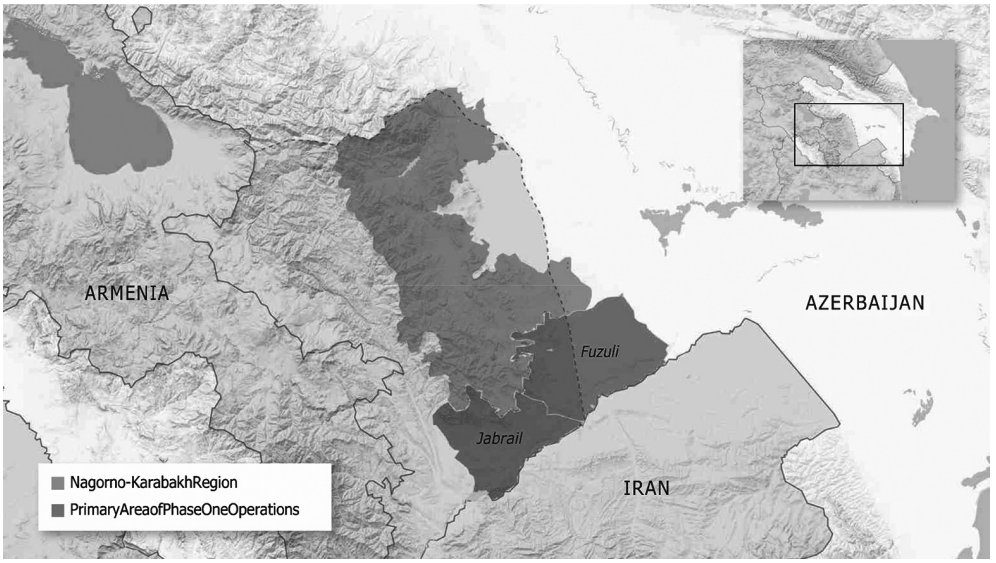
UASs are increasingly part of a network of collaborative platforms and systems in a contested battle space. The figure above illustrates an UAS acting as the link to multiple platforms and systems which could include satellites; multi-role fighters; long-range bombers; aerial refueling aircraft; destroyers and cruisers; carrier strike groups; expeditionary bases; command-control-communication centres; and long-range fires.[7] To communicate across these platforms and systems, UASs need to pass information through layered networks (mainly NATO terms but all nations would need these) are tactical targeting network technology (TTNT),[8] Multifunction Advanced Data Link (MADL),[9] multiband satellite communications (SATCOM), Link 16,[10] and mesh networks.

UAS Provides Global Reach and Multi-Mission Capabilities. Emergence of a multi-polar world brings with it the need to monitor multi-domain activities and threats regionally (a reality for India today), and globally for the big two (USA and China; already happening). This involves covering large continental and maritime geographical spaces as also air, space, cyber and information domains (entire borders and IOR in case of India). There will be ever increasing requirement to possess platforms and systems capable

of collecting and processing intelligence, striking targets if necessary, and operating in a contested environment.

UAS: A Natural Component for Effective Combined Arms Warfare. The broad array of missions listed above clearly illustrates the operational necessity of integration of UAS in combat arms warfare, as also the requirement of a wide variety of UAS that vary in range, endurance, operating heights, and a suite of sensors and weapon systems. Russian defense minister Sergey Shoigu had this to say about UAS, "UASs are being widely used by the Russian army to cope with a wide range of tasks. Over the past ten years the intensity of their flights has been up 7 times, and the annual flight time, 23 times."[11] The obvious response to potency and effectiveness of UAS is adopting passive and pro-active counter-UAS measures, innovations, techniques/drills and SOPs.

ROLE OF UAS AS PART OF COMBINED ARMS OPERATIONS IN RECENT WARS[12]



Source: Geodata for the Nagorno-Karabakh region is courtesy of the Europe and Central Asia Program at the International Crisis Group. See "The Nagorno-Karabakh Conflict: A Visual Explainer," International Crisis Group, https://www.crisisgroup.org/content/nagorno-karabakh-conflict-visual-explainer

NOGORNO-KARABAKH (AZERBAIJAN-ARMENIA) WAR

A historical fault line came alive when sporadic firing started in July 2020, which converted to full scale war on 27 September 2020 between Armenia and Azerbaijan, which lasted six-weeks that killed more than 6,000 combatants. Azerbaijan reversed Armenia's nearly 30-year control over wide swaths of territory in and around Nagorno-Karabakh. Ultimately, Armenia lost 75 percent of the territory it had held in these areas since 1994.[13] The war showcased the significant contribution of UASs in modern combined arms warfare, when waged even by small states; firstly, they are cost effective and pivotal in integrated battle; secondly, were used extensively in information and psychological operations; and even basic low-cost drones can be employed extensively with innovative tactics and are expendable. UAS operations in flat, low lying areas of Fuzuli and Jabrail regions were especially effective, as Armenian forces were easily discovered by ISR assets and targeted with armed UASs, loitering munitions, and artillery. As Azerbaijan Air Force gained superiority, even in the hill sector, the UAS could easily locate poorly, and insufficiently camouflaged armour and artillery locations and enemy defences, which then were neutralized by UAS, special forces, artillery and air. The aspect of counter-UAS actions needs to be highlighted, when Armenians adapted their defensive posture toward UASs, markedly improving their ability to counter these systems with traditional air defence and electronic warfare capabilities as the conflict progressed, likely with Russian assistance. However, these gains were insufficient to alter the war's trajectory after Azerbaijan's early dominance, significant attribution to UAS by all domain experts. Before events led to the war, Azerbaijan invested heavily in Israeli UASs. At the outbreak of the 2020 war, Azerbaijan's inventory included at least seven different categories of Israeli unarmed UASs and two categories of loitering munitions.[14] In mid-2020, Azerbaijan acquired its first armed medium-altitude, long-endurance UAS, Turkey's Bayraktar TB2 (5). While the TB2 emerged as perhaps the most prominent capability deployed during the war, available evidence suggests it is likely that the TB2s used in the 2020 war were owned by Azerbaijan

but operated by Turkish airmen and crews.[15] One other Turkish system, a portable rotary-wing loitering munition known as the KARGU, was used by Azerbaijani special forces in mountain combat against Armenian forces.[16] The KARGU is a portable, rotary-wing tactical drone with ISR capabilities and a small explosive payload.[17] The inability of Armenian air defenses to combat Azerbaijani UASs is well documented. Many of Armenia's air defenses, including the OSA, Krug, and Strela-10, were of Cold War vintage. Armenia had acquired more advanced capabilities, including the Russian S-300, Buk, and Tor-M2KM, but these systems were not effective at countering small, low- altitude threats such as Azerbaijan's UAS fleet.[18] Azerbaijan's operations in these southern regions in the first two weeks of the war reflected a combined arms approach that integrated multiple armed and unarmed systems, loitering munitions, guided missiles, and artillery. Videos and imagery of Azerbaijani operations in these regions show Bayraktar TB2s being utilized for both targeting and strike, operating in tandem with lower-altitude, smaller UASs, such as the Israeli-manufactured Orbiter, as well as other ordinance delivery mechanisms.[19] Overall, the integration of multiple UAS sensors with various weapons, including missiles, loitering munitions, artillery, and other fires, indicated that their cost of entry for advanced combined arms warfare is declining.

IIO and Cost Benefits Using UAS. UAS were extensively used for IIO. By the first day, Azerbaijan posted multiple videos each day of raw drone footage of air and artillery strikes. The primary purpose of this propaganda was likely to solidify domestic public support for the war and the ruling dispensation, as also degrade morale of adversary's armed forces and public. The Azerbaijani government played combat footage on large monitors on public display in Baku. Russia and Ukraine both are repeating it, with Ukraine hoping to further galvanise NATO and international support. None of Azerbaijan's drones cost more than 20$ mn (in fact some as low as 1$ mn, including the TB2) and could be bought and employed in bulk, proving extremely cost effective.[20] A very apt employment is Azerbaijan's use of the Antonov An-2; a single-engine biplane originally manufactured in 1947. In

advance of the 2020 war, Azerbaijan retrofitted numerous An-2 aircraft with remote piloting capabilities and added armaments to some. This allowed Azerbaijan to conduct effective suppression of enemy air defences (SEAD) operations using an outdated, expendable airframe.[21] An-2s were deployed as bait against Armenian air defences (AD), and very often the Armenian AD engaged the An-2 to shoot it down, resulting in them exposing their positions, leading to their neutralisation by UAS and other resources.

THE UKRAINE WAR

The deployment and employment of UASs surged exponentially during the Ukraine war as part of combined arms warfare. There is no dearth of videos, written or spoken material on the internet. UAS have been deployed in multi-task-mission mode extensively, employing one or multiple/ swarm UASs. All tasks enumerated at the start are being executed in this war. Because of the effectiveness of UASs, Russia and Ukraine have also developed counter-UAS tactics, techniques, and procedures. The Russian offensive started with them using UAS as decoys to expose Ukrainian radars and air defence systems. These actions facilitated an opening salvo of missile strikes, including from Kalibr cruise missiles and Iskander systems, on Ukrainian AD.[22]

EMPLOYMENT ILLUSTRATIONS AND MAJOR LESSONS

A new term "kill chains", has emerged which is the process of gaining an understanding of the battlefield, identifying a possible target, determining the target's location and other pertinent information, deliberating what action to take, and making a decision that creates an effect to achieve an objective (such as conducting a strike).[23] The Russian military has long identified UASs as playing an important part of its "reconnaissance strike complex", which is designed for the coordinated employment of high-precision, long-range weapons linked to real-time intelligence data and accurate targeting.[24] Russian forces have used a variety of UASs and loitering munitions in Ukraine, including the Orlan-10 and 30, Forpost-R,

Eleron-3, Granat-1 and 2, Israeli Zastava, mini UAS Takhion-4, Orion, and loitering ammunition ZALA-421. Russia has also imported UASs from Iran, including the Shahed-131 and Shahed-136.[25] The short-range Orlan-10, launched by folding catapult, has been the most widely used UAS in the Ukraine conflict and is the most numerous in Russian military service. Each Russian land force division and brigade has an organic UAS company equipped with Orlan-10s, and Russia possessed around 3,000 Orlan-10s before the war.[26] They were developed for such missions as aerial reconnaissance, electronic warfare, detection of radio signals, target tracking, observation, and monitoring. It can accommodate photo and video cameras, a gyro-stabilized TV camera, and an infrared imager.[27] Russia's For post-R, which was developed by Israel Aerospace Industries as the Searcher Mk II (in service with Indian Armed Forced less the weaponised version), is capable of reconnaissance and strike and is equipped with indigenous software, datalinks, electro-optical sensors, an APD-85 piston engine, signals intelligence sensor packages, and a reinforced fuselage for additional survivability.[28] It includes ground control stations, antennas, and logistics support equipment. The Eleron-3, a small, tactical delta-wing UAS has been mainly used for ISR.

Ukraine has been operating several types of UASs.[29] Once again, the Turkish Bayraktar TB2, has been in the forefront. It performed a range of ISR and attack missions, including firing MAM-C and MAM-L guided bombs, long-range anti-tank missiles, Cirit laser-guided 70-mm rockets, and TUBITAK-SAGE laser-guided rockets. Ukraine also operated small A1-SM Furia flying-wing UASs for day and night reconnaissance; hand-launched Leleka-100 and Spectator-M mini-UASs for artillery spotting and aerial reconnaissance; the Punisher UAS produced by UA Dynamics were used to strike military targets; and larger indigenously produced PD-1s and UJ-22s.[30] Ukrainian forces have utilized off-the-shelf commercial UASs, such as DJI Mavic 3 quadcopter, which has a retail price of roughly $3,000. In some cases, Ukraine has manufactured UAS parts with 3-D printers.[31] In addition, the United States has provided several loitering munitions to Ukraine, such

as the tube-launched Switchblade 300 (with an Orbital ATK high-explosive warhead) and the long-endurance Phoenix Ghost.[32] The Phoenix Ghost, for example, is a tactical loitering munition that can fit inside a backpack, hover over a target for approximately six hours, and strike it with an explosive munition. It has infrared guidance and can operate at night.[33]

ELABORATION OF EMPLOYMENT IN SPECIFIC ROLES

- **Domain Awareness:** This task has always been the mainstay of UAS so far, but expansion of domains has been exploited during the war. The sensors on Russian and Ukrainian UAS platforms have collected signals intelligence, videos, and other information for operational use by ground, air, and maritime forces. UASs can carry photo and video cameras, a gyro-stabilized television camera, an infrared imager, and signals intelligence sensors (including direction finders).[34] These capabilities have also allowed UASs to be useful for post-strike battle damage assessment (PSDA). Similar to 2020 war, both have used UAS as decoys. Russian started their special military operations deploying decoys, while there are indications that Ukraine has used Tu-141 UASs as decoys for similar purposes.
- **Target Identification and Fixation.** UASs used extensively to identify and fix targets for artillery and aircraft as part of combined arms operations. In one operation, Ukrainian ground forces used forward-deployed UASs to identify a Russian infantry unit near Bakhmut in Donetsk, Oblast and fed the information to a command and control center, which passed it to Ukrainian soldiers that hit the Russian unit with a 122-mm howitzer.[35] Ukrainian forces have utilized Kropyva, an intelligence mapping and artillery software populated by information from UASs and other sources. Forward-deployed tactical units have downloaded the software and continuously updated it on handheld tablets and computers. Ukraine has leveraged Starlink, a commercially owned (Elon Musk) satellite internet constellation that provides high-speed, low-latency broadband internet using advanced satellites in low

earth orbit for identification. As one Ukrainian military official noted, "We use Starlink equipment and connect the drone team with our artillery team. If we use a drone with thermal vision at night, the drone must connect through Starlink to the artillery guy and create target acquisition."[36] Russians have employed Eleron-3 or Orlan-10 UASs to identify potentially targets, such as Ukrainian C3 centres, infantry or main battle tanks; pass the information, including the type of target and its coordinates, to command and control facilities; and distribute it to systems that can strike the target, such as 2S19 Msta-S 152-mm self-propelled howitzers or Tornado-S 300-mm multiple launch rocket systems, as fast as within 3 to 5 mins, while with electronic warfare direction finding, acoustic reconnaissance, or counter-battery artillery radar, it might take Russian artillery half an hour for accurate artillery fire. If Russian forces are able to keep a UAS on a target, they can adjust fire in near real-time, even if the target is moving.

- **Strike.** Russia and Ukraine have utilized UASs for strike missions, including against land, air, and maritime targets. Ukrainian Bayraktar TB2 drones have struck numerous Russian targets, such as howitzers, main battle tanks, supply trucks, towed artillery, maritime vessels, command posts, logistics depots, and Buk, Tor, Strela, and ZU-23 air defense systems.[37] Illustrating UAS deployment in multi-domain environment, between April 26 and May 8, 2022, Ukrainian TB2s targeted several Raptor-class patrol boats, a Sarna-class landing craft, and helicopters in and near the Black Sea.[38] Russia has also conducted strikes with UASs, including Orlan-10s armed with freefall high-explosive fragmentation grenades. Russian forces have also utilized Iranian Shahed-131 and Shahed-136 UASs to strike targets deep inside Ukrainian territory. These types of UASs posed challenges for the Ukrainian military because they can fly at low altitudes that make it difficult for air defences to detect. In October 2022, for example, a Shahed-136 struck a Ukrainian military headquarters roughly 50 miles south of Kyiv, causing significant damage to the facility and surrounding infrastructure.[39] Raising global

apprehensions, as recent as May/June 2023, Kviv used UAS to strike wealthy districts of Moscow.[40]

- **Electronic Warfare (EW).** Both utilized UASs for EW. For example, Russia has used RB-341V Leer-3 electronic warfare payloads mounted on Orlan-10 UASs to target Ukrainian cell phone networks. More broadly, Russia has utilized UASs, such as the Orlan-10, to jam GSM 900, GSM 1800, 3G, and 4G signals within a radius of roughly 6 kilometres. Russian units have also utilized Krasukha-S4 electronic warfare systems to take down Ukrainian UASs.[41] Effective use of electronic warfare can cut off drone pilot communications, interrupt live video, or force systems to crash or retreat. In response, Ukraine has attempted to counter Russian electronic warfare, such as by using a radar-homing seeker payload for explosive-laden UAS. Since most electronic warfare complexes take between 25 to 40 minutes to set up, forcing displacement can be an effective means of suppression that, in turn, can create windows of opportunity for Ukrainian UASs and reconnaissance teams to communicate the position of Russian systems in real-time and determine the exact coordinates of positively identified targets.[42]
- **IIO.** Extensively employed as visuals of drone strikes from both sides are flooding social media platforms like YouTube, Twitter, Telegram, and TikTok. UAS surveillance has also provided high-quality imagery of ground engagements that is reminiscent of video games.
- **Counter-UAS Activity.** The high intensity and highly effective combined arms UAS employment led to concrete steps by Russia and Ukraine to develop and execute counter-UAS tactics, techniques, procedures, and capabilities (both passive and pro-active); which are constantly evolving, specially efforts to break the kill chain between the operator and the UAS. Both nations have suffered high rates of attrition. Many have been shot down on the battlefield or have been subject to electronic jamming. TB2s and Russian Orlan-10 and For post have been vulnerable to air defense systems, air attacks, and EW because they are slow, large, low-flying, and radio-controlled. Russia has used the Shipovnik-Aero, a truck-mounted

jamming system with a range of 15 kilometres optimized for targeting UASs. The system has detected UASs through their control frequency, analysed and reconfirmed the information, and jammed the command frequency. The system has also been used to override the position of the UAS so that return-to-base protocols lead the UAS to land in a location designated by Russian forces.[43] Employment of various early warning and air defence radars used for UAS detection, and EW radars to jam and disrupt their communications; while to target UASs and ground control stations, Russian forces have used machine guns, air defense systems, such as the Tor missile system, 152 mm howitzers, 300-mm multiple launch rocket systems, and Tochka-U systems. Russian successes over time in targeting Ukrainian UASs have led to a lifespan of roughly seven days for a Ukrainian UAS.[44] Ukraine has followed suit, and has maintained organic man-portable air-defence teams, sometimes equipped with visually guided systems, such as Starstreak and Martlet, to target UASs. However, as UASs become more autonomous and less dependent on GPS, jammers will be less effective.[45]

- **Suppression of Artillery Fire.** Russian forces assessed that Ukrainian "UASs, high-precision loitering, and artillery ammunition and communications equipment rely on positioning through the reception of signals from satellite radio navigation systems."[46] Learning from above, they instructed own forces to continuously suppress access to satellite navigation through regular operation of the Pole-21 system and the R333Zh, both on maximum power using omni-directional jamming. They realised that the impact on command and control could be limited by linking command posts by ground-laid field cable. Both the Pole-21 and R330ZH systems were turned off prior to the initiation of Russian artillery strikes that might require accurate satellite-based positions.
- At cost of repetition, minimal risk to human life is associated with UASs; risk increasing exponentially in heavily contested air space widens like in Ukraine.

UAS LOST BY PLATFORM TYPE

UAS Type	Number Lost	UAS Type	Number Lost
Military Forces of Russia	169	Military Forces of Ukraine	41
KBLA-IVT	1	Athlon-AviaA1-SMFury	4
Enix E95M	3	DeViroLeleka-100	3
Enix Eleron	10	Spaitech Sparrow	1
For post-R	3	TB2	11
Kalashnikov Group KUB-BLA	1	Tupolev variants	5
Kronstadt Orion	1	UkrjetUJ-22	1
STCOrlan variants	101	Unspecified loitering munition	1
Izhnash Takhion	2	Unspecified VTOLUAV	1
ZALA421-16E2	3	Unknown	14
Unspecified reconaissance drone	2		
Unknown	42		

Source: CSIS analysis using data from open-source websites ACLED and Oryx. Data collected runs only from February–May 2022.
Note: the NYT of May 23, 2023 quotes loss of 10000 UAS per month.[47] EurAsian Times writes of Russia smashing 337 UAVs per month; both due to electronic warfare.[48]

US Developing and Testing Advanced Communication Packages. Ever since the Nogorno-Karabach war, USA and NATO has extended special focus to employment of UAS in combined arms exercises. Exercise Northern Edge 21 was one such exercise involving US Indo-Pacific Command (INDOPACOM), with a pivotal task of test bedding advanced UAS packages.[49] The primary UAS integrated was the MQ-9 Reaper, including the so-called "Ghost Reaper," with upgraded communications packages and machine learning capabilities. The modifications and modernizations include new sensors and anti-jamming capabilities, which will be better suited for strategic competition and major power threats.[50] The MQ-9 Reapers integrated at least four new payloads. The first is the Reaper Defence Electronic Support System (RDESS), which "collects and geo-locates signals of interest from standoff ranges", and allows

the MQ-9 to conduct ISR operations and precision targeting at a sufficient standoff distance from the target to avoid enemy countermeasures. The RDESS with additional electronic countermeasures, enhances the survivability of the existing MQ-9 airframe.[51] The second and third new payloads facilitate communications and data flows consistent with the "sense and integrate" pillars of the JADC2 strategy; enabling communications interoperability across different protocols and radio networks; probably stopgap solutions before achieving machine learning and integration.[52] The final new payload is the MQ-9 Centerline Avionics Bay (CAB) pod, designed to integrate high-performance onboard computing capability for processing sensor data onboard the aircraft. Continuous modernization across tactical sensors in the air, space, sea, and land domains will result in these battle networks collecting larger and larger quantities of data.

HIGHLIGHTING SOME PIVOTAL LESSONS LEARNT

- '**Survivability in Contested Airspace'.** Achieved by increasing standoff distances; reducing exposure to air defences; hardening the existing systems to with stand communications jamming and other electromagnetic attacks. Sensitive and vital targets will always be worth the risks and attrition.
- **'Nodes in an Integrated Battle Network'**. Ingesting data from air, land, sea, space, and cyberspace and relay this data back to decision makers and joint fires.
- **Multi-Mission ISR Capability**. Includes cognitive inputs like signals intelligence, electronic intelligence, measurement and signature intelligence, imagery intelligence collection, the latter needing full motion video and hyper spectral, multispectral, and synthetic aperture radar packages.

EMPLOYMENT OF UAS IN COMBINED ARMS OPERATIONS IN THE INDIAN CONTEXT

Wars, confrontations and multi-domain strategic and operational global crisis situations, and military exercises in just the last five years, has

convincingly showcased the necessity of integrating and possessing integral UASs for combined arms warfare. It does not require rocket science to deduce that India needs to integrate them for conduct of MDW. With our regional power status, ever-increasing strategic space, and expectations of the global powers and Global South, India has to urgently surge her UAS capacities and capabilities. With our boundary disputes against collusive China and Pakistan, and fickle immediate and regional neighbours; against the backdrop of a belligerent hegemon China, 'the innovative employment of UAS in multi-domain operations will keep us in contest and prove a game changer. Our contentious, active borders along high-altitude Northern borders and LC, coupled with increasing interventions by adversaries in the IOR, dictates the mandatory integration of UAS. Enhanced employment in counter-infiltration-terrorist operations will remain a key imperative. UAS role and potency in conventional and hybrid confrontation and conflict/wars has been discussed in detail, and will not be much different for India. After due diligence and deliberation, I feel that almost all the roles and tasks envisaged above will be executed by Indian Armed Force, PMF, intelligence agencies, ISRO, and even security agencies dealing with the economy (ED), logistics et al., with minor modifications/change in profile, drills and payloads. We too will need UAS increasingly for multifarious tasks; collect and process vast amounts of information on adversary activities as part of balance-of-power competition: across a rich variety of terrain, space and water (Indian Ocean Region). We need UASs that can operate with extended range, multiple-payloads, and latest system packages to contest current and future confrontationist environment. UAS intrusions from China and Pakistan are a reality and occurring with increasing frequency and regularity. We need to train and adopt counter-UAS tactics as discussed, in response to the proliferation of UASs.

CONCLUSION

UASs are playing a dominant role in multiple domains during peace and war. They have been particularly valuable in a contested environment

without risking loss of life. It is too early to pass judgement on those who feel that role of UAS is overstated, and those who feel that UASs have brought about a 'revolution of military affairs' and in conduct of warfare. One thing is certain; UAS will gain increasing prominence and pre-eminence in MDW during the entire competition-confrontation-conflict stages. Recent wars specially the Ukraine war has cemented the inescapable employment of integral, interconnected, multi-role UASs in combined arms warfare; and has brought significant payoffs to the side which employed it most optimally and innovatively. India and our armed forces have been slow starters in incorporating UASs in multi-domain operations, but I am confident that with our historical entrepreneurship and innovative skills and perseverance, we will accelerate and level the playing field with our adversaries, specially China, which has now become a strategic imperative.

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