THE CREDIBILITY OF AERIAL COMBAT DRONES: CHANGING EQUATIONS

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Armed/combat drones are gaining military significance as conflicts worldwide have proved the utility of these tactical weapons in battles. Secure communications data links and military-grade security are essential for their use. Aerial combat drones provide consistent and dependable support to war-fighter components. These machines have leveraged advanced networking capabilities with improved weapons capabilities, heavy fuel engines, anti-icing and enhanced avionics, providing real-time situational awareness, troop convoy support, and cutting-edge reconnaissance effects for dominance in every domain. High-definition cameras for situational awareness with ultra-high-resolution 3D imaging that sees targets in three dimensions (3D), gives the war-fighter depth, perception, and aids in target development, and Improvised Explosive Device (IED) detection, are features of these machines. Drones have also increased payload capacity, reliability, practicality, and maintainability. Using armed drones to hunt and destroy suspected threats outside conventional battlefields is a new departure in a country's defence policy. Drone strikes may be an indispensable tool for protecting national interest from the dangers the adversary would perpetuate on the strategic

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targets. They present a novel method for dealing a lethal blow to those organising, preparing, and executing violent attacks from outlying bases, and disturbing and harming their potential. Drones represent the meeting point of two trends in military technology: the increasing precision of weapons and the rise of robotics or Artificial Intelligence (AI). When these increasingly sophisticated capabilities are combined, they result in a drone aircraft that can be flown remotely and is capable of delivering a lethal payload without endangering the pilot.[1]

Drones have long been used in combat; the Teledyne Ryan 147, capable of launching Shrike anti-radar missiles, was first used in 1964 by the United States in reconnaissance missions over Vietnam and China, scouting for decoys and forcing the enemy to reveal its positions.[2] Drones were used in the US' wars in Iraq and Afghanistan, but as technology advanced, so did the capabilities of the drones. The US famously turned Predator drones into weapons, but that was almost two decades ago; the Israel Harpy drone is a loitering autonomous weapon platform whose integrated sensors identify and target radar sites by detecting electro-magnetic emissions from radar equipment. Israel used drones to affect Lebanon, beginning in the 1980s.[3] Since then, technological advancements (miniaturisation feature) have enabled even smaller drones like the Israeli Hero 30 that can carry 1lb (0.454 kg) explosive (for anti-personnel missions)[4] or the much more complex loitering kamikaze. The number of countries producing and selling high-performance drones has grown. Advanced remotely piloted aircraft that can fire guided

1. John Kaag and Sarah Kreps, *Drone Warfare* (Cambridge: Polity Press, 2014), p. 34.
2. Robert Barkan, "The Robot Air Force is About to Take Off", *New Scientist*, vol. 55, no. 88, 1972, p. 282.
3. Stuart Casey-Maslen, Steven Haines, *Hague Law Interpreted: The Conduct of Hostilities under the Law of Armed Conflict* (Oxford: Bloomsbury, 2018), p. 256.
4. Ibid., pp. 256-257.

weapons on and off the battlefield have been created by companies in China, Turkey, Russia, and other countries. A new chapter in the history of conflicts has begun with the United States' significant employment of drones to hunt down and kill rebels in Afghanistan and Iraq. The US Central Intelligence Agency (CIA) flew the first Hellfire armed Predator mission in Afghanistan on October 7, 2001.[5] While the pilots were safely seated in a ground control station, this high-flying, remotely controlled aircraft could engage the targets. Drone use in hazardous skies has become politically affordable to keep the crews safe. More and more nations are acquiring this military capability for various purposes. There is a possibility that drones will be deployed more frequently because other countries will emulate the precedents set by the United States. The United States is creating an international norm on how to employ drones. This new norm may be used as justification in the future by countries like China, Russia, or any other country when deploying advanced drone technologies against similar enemies. China is positioning itself as an "alternative supplier" of advanced drones. It is developing the High-Altitude Long-Endurance (HALE) reconnaissance drones. Similar models (CH-6/Cai Hong 6/Rainbow-6, WZ-7 Guizhou Soar Dragon)[6] have been spotted operating out of Xinjiang's Malan airbase, close to the Sino-India border and the South China Sea.

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The proliferation of drones, especially armed ones, and their considered use outside conventional battlefields, is setting dangerous precedents for use of force by nations and armed groups worldwide. The most hazardous type of drone (i.e., long-range strategic armed drone) is likely to proliferate

5. John Prados, *The US Special Forces: What Everyone Needs to Know* (New York: Oxford University Press, 2015), p. 125.
6. Kelvin Wong, "China's CH-6 Armed Reconnaissance UAV Development Breaks Cover", *Jane's*, April 21 2021, available at China's CH-6 armed reconnaissance UAV development breaks cover (janes.com). Accessed on July 4, 2022.

quickly, and it is doubtful whether existing international agreements will suffice to control countries' development of the capacity to project power using drones. States will probably use armed drones to carry out strikes beyond their borders, citing US precedents. The significant issue is whether drones are revolutionising the conduct of warfare and whether they will tend to escalate conflicts and promote instability.[7] It won't be long before man nations adopt the technology to develop different aerial drones on their own, and use them for their own unique needs.[8]

A prominent feature of drone use is psychological pressure: an invisible weapon is hovering 24 hours above the troops, and they hear an unexpected whistle and have only seconds to escape. Imagine the deadly psychological pressure on soldiers in the field. It's a constantly changing game. Countries have used drone strikes effectively, with only a few hiccups. It will result in the evolution of Short-Range Air Defence (SHORAD) systems and capabilities on the defensive side. The most significant change will be in defence strategy and doctrine. How can an army move and attack at night using low-cost thermal-optic drones? How can soldiers layer and blend air defence against drones and traditional air systems? What strategies will be employed in a decade or two? These issues should be a part of every nation's strategic-military doctrine.

FORCE MULTIPLIER OR NOT?

The first combat drones were large and based on reconnaissance drones. When an aircraft can fly for 20 hours at altitude, it usually means that it can carry a few small missiles in exchange for a shorter flight endurance and slightly lower flight altitude. The success of today's drones in Syria or over Nagorno-Karabakh is comparable to that of US drones in Iraq and Afghanistan, but context is critical. When the United States used drones, the enemy was already so battered that its drone operations were counter-insurgency ones (Afghanistan and Pakistan). Drone victories occurred after

7. Avery Plaw, Matthew S. Fricker, Carlos R. Colon, *The Drone Debate: A Primer on the US Use of Unmanned Aircraft Outside Conventional Battlefields* (Maryland: Rowman & Littlefield 2016), p. 5.
8. G.S. Sachdeva, *Drone Operations: A Jurislogue* (New Delhi: KW Publishers, 2015), p. 78.

the US military defeated any threat the adversaries could have used to counter the drones. As a result, American drones flew around and selected their targets. America's use of drone strikes seems driven exclusively by self-interest. Drones are critical counter-terrorism tools that advance US interests around the globe. The combination of persistence and responsiveness, high-quality intelligence infrastructure, and tacit host-state support have made drones the preeminent tool for the US' lethal operations against suspected terrorists and militants where states cannot afford to deal singlehandedly with their threat. As a result, drones are not just another weapon platform; instead, they provide a country with a distinct capability that significantly reduces many of the inherent political, diplomatic, and military risks of targeted killings.[9]

In Syria or Nagorno-Karabakh, the enemy has not been entirely defeated, and drones are used to pursue frontline targets rather than mop up various insurgencies actively. Here the security environment has changed, resulting in multi-domain hybrid attacks and reflecting the new reality of war and conflict management in the 21st century. Due to the multi-dimensionality of hybrid conflicts, drones represent a means of choice for hybrid actors. Although the Syrian Army has been battered by a decade of conflict, Turkey used drones against the Syrian forces rather than the insurgents. Syria typically employs outdated technology. A few systems cannot make the entire Surface-to-Air Missiles (SAMs) network effective; given the size of the Syrian and Turkish forces, it is clear that Syria cannot do much against the Turkish drones. Syria has some fairly modern S-300 and other SAMs given by Russia. However, massing Air Defence (AD) units to counter counter-attacks is severely limited. When drone strikes hit trucks and wheeled vehicles hauling supplies and reinforcements, the entire defence is weakened, and morale begins to shatter.[10]

9. Micah Zenko, *Reforming U.S. Drone Strike Policies* (New York: Council on Foreign Relations, 2013), pp. 7-8.
10. John Antal, *7 Seconds to Die: A Military Analysis of the Second Nagorno-Karabakh War and the Future of Warfighting* (Oxford: Casemate Publishers, 2022), p. 31.

Drones in combat have capabilities comparable to traditional air superiority but at a lower cost and with fewer errors. Critical elements are in place to overwhelm the enemy when enough surveillance data from drones or other sources, as well as enough drones, are available.

Moving on to Armenia and Azerbaijan, it is common knowledge that the Azeris successfully attacked Armenia with drones; however, this was not a recent development. Drones in combat have capabilities comparable to traditional air superiority but at a lower cost and with fewer errors. Critical elements are in place to overwhelm the enemy when enough surveillance data from drones or other sources, as well as enough drones, are available. The opponent's defences are an important factor to consider. An approximation of Armenia's active and properly manned air defences, such as the Tor systems (Armenia uses the Tor-M2Km based on a KAMAZ-63501 truck chassis), were delivered beginning in 2019, and the numbers of properly trained crew may not match the numbers of contracted vehicles. Because of the Azeri Nakjivan region in the west, a broader area must be monitored. As a result, all Armenian SAM systems, those from the Cold War to the Tor and S-300, were required to cover a large area vulnerable to sneaking in by Unmanned Aerial Vehicles (UAVs) and manned aircraft due to the lack of radar coverage of the battle space. Individual SAM systems can be threatened without overlapping SAM networks; this was true against regular air forces during Israel's wars in 1973 and 1982. The Strela-10 is an old system with a limited range and self-sufficiency in target acquisition (India operates the 9K35 Strela-10).[11] It was used in the Nagorno-Karabakh conflict; without radar, it could have been used passively. It would be undetectable, but the system would be useless. Even with upgrades, the OSA SAM is more capable but still relatively old. Its radar is not very powerful, and it wasn't designed

11. Sheershoo Deb, "Full List of India's Air Defence Systems", *DefenceXP*, August 23, 2020, at https://www.defencexp.com/full-list-of-indian-air-defence-systems/. Accessed on June 27, 2022.

to detect drones (India operates the 9K33 OSA AK)[12]. Because small drones have weaker radar signatures, OSA's effective engagement ranges (15-18 km) may have been compromised.

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During the Nagorno-Karabakh War, Azerbaijan destroyed Armenia's tactical ballistic OTR-21 Tochka, Scud B, and even S-300 SAM systems. To detect the radar systems of the S-300, Azerbaijan used cheap and very old self-flying planes like the Antonov An-2. Later, overwhelming drone attacks were launched, and all of these drones—the Turkish Bayraktar TB-2, Israeli-built Elbit Hermes 900 and Harop, and Azerbaijani-built light suicide drones like the Zerbe—worked together to complete the missions. Pakistan acquired the Bayraktar Akinci attack unmanned aerial vehicle (HALE) and operated the Bayraktar TB-2 Medium Altitude, High Endurance (MALE) armed with laser-guided munitions like the L-UMTAS ATGM and smart micro munitions like MAM-C/T/L; and possible integration of the TB-2 with the Saab Erieye or Chinese ZDK-03 Airborne Warning and Control System (AWACS) for the Suppression of Enemy Air Defence/Destruction of Enemy Air Defence (SEAD/DEAD) roles. Similarly, the TB-2, directly linked with the JF-17 or J-10 for future missions inside enemy territory, is a potential threat.

Furthermore, the Turkish Bayraktar TB-2 drones could have used missiles that outranged the OSA or Israeli-made suicide drones. The OSA isn't well suited to attacking multiple targets, especially if they come from different directions. The OSA SAM vehicle has little chance of defending itself when two such drones are launched from opposite ends. Using three or more drones almost always ensures mission success. The Bayraktar TB-2s are frequently operated simultaneously within the range of several 9K33 OSA systems without ever being targeted. Armenia probably thought that using them in much more significant quantities so that their engagement would overlap, could at least partially compensate for the 9K33's limitations.

12. Ibid.

This would imply that a TB-2 would inevitably fly into the range of another nearby system if it were to engage a 9K33. Armenia learned that even with their radar systems activated, these systems could not detect the TB-2s flying-circles above them. At least 16 9K33 OSA were destroyed without any TB-2s being lost, probably because of the TB-2s' low radar visibility and possibly Azerbaijan's use of Electronic Warfare (EW) tactics.[13] The Tor system's radar is more difficult to jam and can engage more targets at once, but it is also more expensive. Because its crew cannot be retrained after its loss, investing in 5 or 10 suicide drones per Tor vehicle may be a long-term winning strategy. In December 2015, the Ministry of Defence (MoD), Government of India, approved the acquisition of up to five S-400 SAM systems from Russia for a price range of $4.5 to $7 billion.[14] Each missile is an expensive, complex item that costs over a million dollars, and the S-300 or S-400 is wasted on low-cost drones. When attempting to engage drones with either the S-300 or S-400, one reveals the location of the SAM system components, so it doesn't matter if several drones are down; the enemy knows where the system components are and can proceed to overwhelm them with various drones or other attacks.

However, the SAM system is vulnerable to being overwhelmed or surprised by numbers and jamming. A SAM, which costs millions of dollars and has a priceless crew, can be defeated by any nation with an excellent state-of-the-art jamming system and numerous drones. Kamikaze drones are extremely dangerous in addition to loitering suicide weapons and missile-armed drones. The Israeli Harop is a sophisticated system that can even return home if no target is found. India bought 54 Harop drones and two AWACS for $800 million from Israel. The initial price tag for communication equipment, launchers, and guidance stations can rise to $10 million per aircraft. However, as India's purchase of additional Harop drones demonstrates, once the ecosystem is in place, subsequent drones may cost

13. Stijn Mitzer and Joost Oliemans, "Aftermath: Lessons of The Nagarno-Karabakh War are Paraded Through the Street of Baku", *Oryx*, January 26, 2021, at https://www.oryxspioenkop.com/2021/01/aftermath-lessons-of-nagorno-karabakh.html. Accessed on June 29, 2022.
14. Nasima Khatoon, "India's BMD Programme and Acquisition of S-400 Air Defence System", *CAPS In Focus*, November 25, 2021, at https://capsindia.org/indias-bmd-programme-and-acquisition-of-s-400-air-defence-system/. Accessed on June 27, 2022.

a million or more each. Because all real-world applications of drones have occurred in situations where one side is militarily much more powerful than the other, it follows that drones are now unstoppable. As a result, drones are a tool for achieving victory with fewer casualties and lower material costs than losing a costly SU-30MKI or MiG-29. Stronger militaries can take advantage of technology, but what if two countries with equal technological levels and strength attempt to rely primarily on aerial combat drones for surveillance, strike and kill operations? In such an eyeball-to-eyeball conflict, there would be numerous issues. Techniques for fooling and overwhelming air defence radars and missile systems, decoys and electronic jamming, and then destroying key targets with drones or loitering munitions to identify and strike will become more cost-effective. Another issue is that all drones must be piloted. A drone is a machine that is controlled by an external form of control. Drones are, thus, remotely controlled machines that can take many forms.[15] Because drone sensors rely on electronic signals, jamming or cutting off the data link channels through which the drone receives commands could be destructive.

KINETIC AND NON-KINETIC OPERATIONS

War is not won with super-elaborate, super-expensive weaponry. There are misconceptions about the TB-2s and their philosophy as well. They are affordable, dependable, expandable, simple to use and maintain, and will handle 90 per cent of the routine tasks. More extensive, better drones are more than twice or three times as big as the Global Hawks, MQ-1 Predators, MQ-9 Reapers, or Chinese Wing Loongs (more easily detected and 5-7 times as costly). A TB-2 can be disassembled by any trained soldier, transported on a flatbed truck, put back together, and launched from any road in 30 minutes. However, this exercise cannot be performed with other advanced drones like the Global Hawk, etc. The TB-2 has low visibility and detectability due to its size, reinforced fibre glass construction, and slow speed. As a result, it may be much more difficult to distinguish it from the "ground clutter".

15. Plaw, et al., n. 7, p. 7.

As long as they are remotely controlled, all drones will be vulnerable to being cut off from their command centres by powerful ground-based jammers. This can damage their electronics and make them vulnerable.

Faster moving drones will probably have a larger radar cross-section and may be easier to detect by the Moving Target Indicator (MTI) radar. Smaller drones may be more difficult to target because they require higher frequency radars, but high-frequency radars suffer more from atmospheric and water vapour depletion. Another element that can significantly increase their range is satellite uplinks. Using the "Starlink" network (currently functioning in Ukraine) that gives an internet connection, can make them much more impervious to jamming. It makes sense if a few TB-2s are lost in exchange for destroying the enemy supply's, logistics, and morale.

Furthermore, the ground artillery and rocket systems that hit the TB-2's designated targets do more damage than the TB-2's micro munitions. And the force needs to launch costly medium-long range air defence missiles at the TB-2 drone, which can fly at 6,000-7,000 m altitude and fire weapons from 18 km away, beyond the range of Man-Portable Air-Defence Systems (MANPADS) or anti-aircraft guns. Also, comparing the MQ-9 Reaper or Wing Loong to the Bayraktar TB-2 is not valid because they are different classes of drones, with the TB-2 being a small drone designed primarily for reconnaissance with occasional high-precision strikes, whereas the Reaper is designed for strikes. Smart ammunition is a success factor because it is inexpensive and does not require an expensive engine. The following factor is the software, which is constantly updated.

There are more chances for stealth drones to survive, like the RQ-170 Sentinel or the SU-70 Okhotnik, among the larger drones. Smaller ones, such as the TB-2, also have a place because they are intrinsically stealthy. Although more significant and complex drones, like the General Atomics MQ-9 Reaper, are not cheap to develop or operate, smaller drones are becoming more ubiquitous in conflict zones. Limiting the proliferation

of these smaller drones and the ability to weaponise them is a regulatory nightmare for government agencies worldwide. However, as long as they are remotely controlled, all drones will be vulnerable to being cut off from their command centres by powerful ground-based jammers. This can damage their electronics and make them vulnerable.

Drones can be used effectively after the central forces have destroyed the air defences. However, on their own, they are not fully effective in a conventional war involving nations with a decent selection of air defence systems.

Drones can increase the power of an existing force but cannot take its place. That implies that these would be effective in addition to the existing jets, artillery, and missiles. They might be effective on their own against nations without adequate air defence systems, like Armenia. However, standard air defence mechanisms will make them impractical in a proper battle against a good army. Drones can be used effectively after the central forces have destroyed the air defences. However, on their own, they are not fully effective in a conventional war involving nations with a decent selection of air defence systems. They cooperate fervently with the regular forces, but drones have not yet progressed to the point where they can replace jets and other major weapon systems. And, no matter how much the manufacturers market their products, Turkey needs more sophistication in the case of the Bayraktar TB-2. If anyone is in that tech league, it's the usual suspects: the United States, Russia, China, Britain and a few European countries. Drones are not the only solution. They must work in tandem with other systems and forces. Turkey and Azerbaijan use drones with Turkey's Electronic Warfare (EW) systems and other loitering/kamikaze drones.

In the future, advanced drones will be used as stand-alone strike platforms, executing missions with the assistance of Artificial Intelligence (AI)/Machine Autonomy and Smart War-Fighting Array of Reconfigured Modules (SWARM) tactics. In January 2018, Russia's Khemim airbase in western Syria was attacked with a coordinated drone strike. This was the first

time the world witnessed drone swarm warfare. Unmanned Aerial Vehicles (UAVs) have the potential to act as force multipliers, allowing the air force to have a large number of aerial platforms that are not only attributable but can also inflict massive damage on a near-peer adversary. Of course, one stealth bomber can do more harm than a conventional bomber. Still, sometimes, there are many relatively cheap and disposable aircraft to deal with a powerful enemy with thousands of potential targets to destroy in the early days of the war. A control drone is a solution; AI can be advanced enough to follow mission parameters. The control drone observes the combat drones from a safe distance and relays data from the human pilots. While drones can be controlled by humans, some may not be, and will attack any predetermined target or, if a signal is lost, the drone will strike the target and then Return to Base (RTB). Drones are less expensive than advanced fighter aircraft and bombers, improving their capabilities more quickly and cost-effectively, allowing counters to various enemy defences or manufacturing them in such large numbers that the enemy cannot shoot them all down. Drones, unmanned aerial vehicles, and optionally manned aircraft are the future of aerial warfare. That is a proven fact. The only point of the expert question is regarding how quickly they will develop and when technology will advance enough for the drones to become primary aerial platforms.

JET WINGMAN

The first step is what the US Air Force refers to as "the loyal wingman," in which drones accompany manned fighter jets and provide them with additional sensors, intelligence, and many missiles and bombs. The Stingray drone, which the US Navy is currently developing, will be used as an aerial tanker, supporting fighter jets by extending their range through aerial refuelling. Hindustan Aeronautics Limited (HAL) will produce India's semi-stealth drone, the CATS Warrior. CATS (Combat Air Teaming System) drones are part of a domestic programme. These drones will be used with the 'Made in India' Light Combat Aircraft (LCA) Tejas aircraft. As a result, four Warriors can fly with a single manned aircraft, which could be the

future team. Each drone will be equipped with weapons and jammers and conduct combat missions.

Logistics and training are also important considerations. Logistics from a safe base should be simple and inexpensive, but there should be only one point of failure. Drone operator training is significantly less expensive than armoured crew training. Drone maintenance is also simpler and cheaper than armoured force maintenance. Putting in the necessary air defence to protect against drones is an additional and significant expense. Drones are primarily defensive weapons that significantly boost a country's security. Armour is incredibly offensive. Drones make initiating armour offences prohibitively expensive. Any offensive against a well-armed drone advisory will require an excellent strategy to neutralise the drones first, or the armour units will be destroyed.

INDIA'S BIG PUSH

India's military is rapidly modernising as it strives to become self-sufficient in drone and anti-drone technology. This can be accomplished through various methods, including indigenous research and development, collaboration with friendly foreign countries, a limited number of off-the-shelf purchases, and extensive domestic production. Two of India's neighbours, China and Pakistan, have made sizeable UAV investments. India already employs many surveillance and combat drones, which have greatly improved and helped the armed forces in recent years. The security agencies in India have been looking for strategies to counter potential drone threats. The armed forces are researching ways to stop drones, such as sky fences, drone guns (e.g., the L-70 World War II anti-aircraft gun has been converted into an anti-drone gun/killer for the Indian Army and Air Force, known as the Zen anti-drone system),[16] drone catchers, and EW capability to combat dangerous and suspicious remote-controlled cheap aerial drones that can transform into

16. Anita Banerjee, "Drone Killer: Indian Army Turns a Vintage Anti-Aircraft Gun into a Lethal UAV Hunting Machine", *The EurAsian Times*, October 1, 2021, at https://eurasiantimes.com/drone-killer-indian-army-turns-a-vintage-anti-aircraft-gun-into-a-lethal-uav-hunting-machine/. Accessed on December 29, 2022.

India needs to develop different drone types and engage in target-based combat. The country must shift its focus toward creating cutting-edge AI-controlled drones with full control station capabilities.

loitering weapon platforms. These steps will encourage the local anti-drone ecosystem's growth. The counter-measures' effectiveness will significantly increase in the presence of a robust early warning system.

India needs to develop different drone types and engage in target-based combat. The country must shift its focus toward creating cutting-edge AI-controlled drones with full control station capabilities that can the deployed near the Line of Control (LOC), Line of Actual Control (LAC), and vast maritime regions for attacks and surveillance. India's Larsen & Toubro (L&T) is developing a HALE class UAV with 72 hours of endurance. Indigenous drone programmes like the Archer/Rustom-1 UAV for reconnaissance and strike missions, the Rustom-2/TAPAS (MALE) dedicated for reconnaissance missions, the SWiFT Unmanned Combat Aerial Vehicle (UCAV) based on the Defence Research and Development Organisation's (DRDO's) Ghatak project (Stealth UCAV), the CATS Warrior project under HAL, and the RUAV 200 coaxial helicopter UAV as a mule drone for high altitude logistics operations in hostile mountainous terrains will undoubtedly improve India's drone capabilities against any threats in both modern and conceivable future wars.

SOME CONSIDERATIONS

Finding the ideal ratio of missiles and reconnaissance drones is the ultimate objective. The pinnacle of conventional warfare is using missiles and reconnaissance drones that can either destroy a target or provide coordinates. Of course, swarm/loitering and kamikaze drones are among the essential weapons. Slow-moving attack drones are only helpful after gaining some level of air dominance. Kamikaze drones launched from the air could be more effective. Before using attack drones, the force must first neutralise the air defences.

Drones are more evolutionary than revolutionary. They are believed to be a dead-end until commercially viable artificial intelligence is developed. Drones can already be jammed in electronic warfare, including the Russian and Israeli portable signal gun that sends out several different types of guidance signals when pointed directly at a drone. Despite not using many drones, a country such as Russia has a very powerful EW capability, including anti-drone defence (Krasukha-S4 electronic warfare system, currently in action in Ukraine). The most effective method of countering drones is EW, which includes jamming the signals of the drone's radio frequency, telemetry, communications, and satellite-enabled geolocation signals. The spread of drone technology is also hampered by the fact that there are already cheaper and more effective alternatives that can perform many, if not all, the functions of armed drones, such as conventional fighters and bombers, helicopters, and cruise missiles. After weighing all possible strategic considerations, countries may opt to develop or purchase a less advanced drone system or some helicopters.

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It's intriguing how drone development is mirrored by aircraft development. Drones were initially utilised only for reconnaissance before starting to drop ordnances on ground forces. The logical next step would be for them to start fighting. Perhaps that isn't as absurd as it seems. It may be more effective than relying solely on ground-based systems if you can picture a friendly drone using Combat Air Patrol (CAP) to deny air space to adversarial drones.

Future drone swarm tactics are frequently discussed regarding the increased use of artificial intelligence and independence. The development of smaller weapons, some specifically for UAVs, will allow them to use smaller platforms that are particularly difficult to shoot down and, thus, difficult to defend against. If used in large numbers, the smaller or swarm

drones could potentially enable states, non-state actors, and individuals to achieve overmatch against a significantly more capable adversary. The drone is too small, made of plastics/reinforced fibre glass and flying too low to be detected by radar (small radar cross-section), and because of its size, it could easily be confused for a large bird. If non-state actors operate such small drones, there is a grave potential threat, as proved by the Houthi rebels who hit two oil installations in Saudi Arabia in 2019. Even the sophisticated Saudi Air Defence (AD) system couldn't prevent the attacks. For most non-state actors purchasing smaller, more rudimentary UAVs, such as remote-controlled aircraft available from the Internet and taking advantage of using UAVs in terrorist attacks may create a psychological winning plan for them though it would inflict minor damage.

Assume two opposing countries, both well-equipped with numerous and diverse drones, go to war. Drones will definitely fly. Even if jet-powered drones flew higher, faster, and stealthily, they would struggle to loiter over enemy territory and survive. They would use powerful sensors to conduct surgical strikes on predetermined targets or scout from afar. When powerful countries go to war, multiple platforms such as satellites and AWACs monitor the air space a few hundred miles above the frontline. On the other hand, drones have lower radar returns unless dedicated stealthy drones are purchased. The detection ranges against them would be significant; combined with the slow speed and small radar cross-section, the sides would have more time to concentrate their defences in critical areas.

On the other hand, operating combat drones over the frontlines would be very popular. Loitering suicide drones would be used extensively because they can circle for hours while receiving new targeting data. It is possible to engage the adversary's SAMs by using small drones that can launch kamikaze attacks and are very tactical platoon-level weapons. India has ordered the Israel-origin kamikaze drone 'SkyStriker' loitering munitions for the army. It is a tactical kamikaze drone with a warhead of 5 to 10 kg, and a range of 100 km.

Against quadcopters and other cheap light drones and not-so-organised belligerents, drone guns, hand-held jammers, or vehicle-mounted drone detectors with limited range will do the work cost-effectively. India has initiated procurement of Counter Unmanned Aircraft Systems (CUAS), which use different techniques for detecting and intercepting drones/swarm drones. India's own DRDO's two anti-drone systems are on the list. The first is a 10 kW laser for 2 km range engagement, and the second is a 2 kW laser for 1 km range engagement, though the systems are yet to be put into mass production. But against bigger opponents with more powerful UAVs, such measures will not work. A multi-layered radar network and SAM network will hinder drone attacks. India's Russian origin 9K33 Osa-AK, 9 K35 Strela-10, 2K22 Tunguska, ZSU-23-4 Shilka, 9K38 Igla-1(MANPADS), QRSAM for loitering/kamikaze drones; Akash, 2k12 Kub, Spyder and MRSAM versions for MALE drones; Barak 8 LR-SAM and S-400 for long-range (HALE) area few that merit mention. The lesson for India is to not rely too heavily on any one combat system; rather, we must use all combat systems, including artillery, cruise missiles, manned combat aircraft, armed helicopters, and armed/reconnaissance drones, to engage our enemies effectively. It is unknown what counter-measures will be available once AI-controlled drone swarms are deployed on battlefields.