Integral Air Support to Land Operations
A Futuristic Perspective

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Offensive use of air power is an important element of modern warfare and is seen as a precursor to the conduct of successful land operations. One of the basic tenets of military operations in contemporary times is the attempt to achieve air supremacy or air superiority, at the very least, to allow the successful conduct of land operations. This means, in a broader sense the land offensive cannot be undertaken until and unless control of the command of air has been achieved. The lessons from Russia–Ukraine war have driven home the fact that air superiority may not be achieved at all, with both sides attempting air denial strategies. In this case, the land offensive needs integral air support of its own, in the form of utilising technologies and tools like drone swarms, autonomous drones and surface-to-surface missiles.

Keywords: *Air power, Air Defence, Drones, Swarms, Pralay, Emerging Technologies*

Introduction

The return of the phrase 'great power competition' in the lexicon of security documents of several countries places conventional warfare at the centre of settling disputes. The ongoing Russia–Ukraine conflict, in particular, has

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ISSN 0976-1004 (print); 2583-7567 (online)

reinforced this notion. However, the advent of emerging technologies—themselves a combination of increasing computation, miniaturisation and commercialisation—has the potential to change how conventional wars will be fought in the future. Also, the 'democratisation' of the air littoral can be viewed both as an opportunity and threat: the former as it places increasingly sophisticated capabilities in the hands of soldiers at relatively cheaper costs; and the latter for the very same reason since non-state actors now possess the ability to pose credible threats to a country's security.[1]

The latent scalability of these technologies—so far exploited by the Ukrainians and Russians equally—implies that future conventional conflict will involve saturation of the airspace at an unprecedented level. Further, the creation of new warfighting domains, such as space, cyber and electromagnetic (EM) spectrum,[2] will divide capabilities and attention. For land operations, this means that certain organic capabilities will have to be created anew. The foremost is integral air support which can support land operations not only in terms of intelligence, surveillance and reconnaissance (ISR) but also target acquisition and kinetic effects. However, in order to visualise the future of these capabilities, one needs to gaze in the past and analyse how land operations have been supported so far. The article looks at a broader canvas of operations across the globe and across timelines in order to draw generalised lessons on air support to land operations. These are then distilled for contemporary and future warfare by looking at emerging technologies.

Air Power: Understanding Basics

Air power is defined as the 'ability to project military force by or from a platform in the third dimension above the surface of the earth'[3] and includes associated infrastructure, such as airfields, personnel and the organisation itself.[4] The importance of this capability is highlighted in the presence of air arms in all the three traditional warfighting services: the army, the navy and the air force. Additionally, paramilitary forces, intelligence agencies and certain other forces, such as the United States Marine Corps (USMC) and the US Space Force, possess aerial capabilities of their own.

In conventional operations, control of the air is supposed to be critical since adversarial air can interfere with the progress of land, sea or air operations. It can vary from zero interference by the adversary (air supremacy), minimal interference (air superiority) to being limited in time and space and greater expectation of interference by the enemy (favourable air situation or FAS). Once control of the air has been established, the next phase of air support

to land and maritime operations starts. This takes the form of battlefield air strike (BAS), battlefield air interdiction (BAI) and air interdiction, which are the application of combat power against ground targets in the tactical battle area (TBA), intermediate depth and depth respectively. In other words, BAS engages enemy ground forces in immediate combat with friendly forces; BAI targets ground forces that are on the battlefield but may join the ground battle in the immediate future; and air interdiction goes after the enemy's strategic reserves, reinforcements and resupply lines.[5] All these are generally conducted within a single TBA and are part of the air force's tactical air support operations.

The term 'integral air support' can be defined as air support specific to a particular service or formation. The term seems to have originated somewhere in the late 19th-century military literature and gained increasing traction from the early 1930s, reaching peak usage in 2010.[6] For example, the Fleet Marine Forces (FMF) are integral air support to the USMC operations wherein they are reserved exclusively for the Marine Corps.[7] On the other hand, aircraft deployed on an aircraft carrier are integral air support to that particular carrier and by extension, the entire carrier battle group (CBG).[8] This does not obviate the need for a longer-range strategic air force, especially when navies are supposed to be operating far away from home shores. The added layer of air support caters for more granular intelligence, surveillance, target acquisition and reconnaissance (ISTAR) and kinetic capabilities for the CBG. Similarly, the requirement of integral air support over and above what is provided by the air force assumes major importance due to reasons clarified later.

There is an implicit assumption that no major surface operations can commence before adequate control of the air has been established. On the modern battlefield, this assumption may not hold true. This is due to the spatially dispersed nature of deployments and dispositions of enemy air, ground and air defence (AD) assets, communication and Global Positioning System (GPS)-denied environments, relatively transparent nature of the battlefield precluding major surprises, 'democratisation' of the air littoral and the need for parallel operations in multiple domains. One of the major implications of operating under such situations is that there will be an exponential increase in the number of targets for the air force. Land operations may need to be jump-started using their own integral air support capabilities and in this phase, emerging technologies can play a major part. This will also enable the air force to focus on strategic and operational targets, rather than exhausting limited platforms and ammunition on the tactical battlefield. Before delving

into the details of this line of thought, it is necessary to see, in brief, how air power has evolved over time, with a special focus on land operations.

Evolution of Air Power Strategy

General Giulio Douhet, writing in 1911 (revised edition in 1919), coined the term 'conquest of the command of the air'[9] or the total destruction of enemy air power, preventing it from flying. He then laid out, conceptually and somewhat pseudo-scientifically, the doctrine, tools and envisaged effects of such an instrument. The crux of his argument was the use of air power to force an enemy nation to capitulate by means of a bombing campaign directed against the morale of the population.[10] The presumption was the prevalence of the notion of total war and that air power, bypassing the usual friction points manned by the army and navy, could straightaway direct armament into the industrial centres, communication networks, and even use poison gas against civilians to collapse the enemy's resistance and degrade his morale.[11] The introduction of a third dimension directly affecting the civil population was a novelty in that era. Most of the civilian population had been insulated from the horrors of war through distance from the battlegrounds and subsequent layers of the defending army, ensuring that attrition remained the only means of attaining a semblance of victory. Douhet also laid the foundations for the concept of an independent air force, separate from the army and naval air auxiliaries.[12] He believed in the absolute offensive nature of air power and postulated that air power acting in support of army and naval forces would always perform suboptimally, since the importance of the army and navy was declining.

Certain arguments of Douhet retain their value to this day, especially his emphasis on air power's ability to conduct parallel operations of war, rather than the army's conception which is sequential. He was also of the view, proven correct in the long term, that only economically and technologically advanced nations could have strong air forces and argued for a civil–military cooperation and interoperability in the aviation complex.[13] Brigadier General William 'Billy' Mitchell took this a step further and argued for exceptionally daring and professional young men donning the pilot's helmets in pursuit planes, his 'air knights', who, combined with the bomber crew, could deliver deadly armament into the enemy's industrial heartland.[14] Mitchell was looking at ways to bypass the stalemated conditions along the western front, if they occurred again. He envisaged attacks against cities using bombers at multiple altitudes and from all sides so that defences would be overwhelmed

and the only defence would be the enemy air force since no one on the ground or water could counter this force.[15] This, again, assumed that Mitchell's force had air supremacy, though those notions had still not been crystallised as foundational. Finally, the third of the trifecta of the bombing enthusiasts, Sir Hugh Trenchard, had similar notions regarding the use of bombing to directly hit civilian centres since, in his words, 'civilians are not disciplined and it can not be expected that they will stick stolidly to their lathes and benches'.[16] The Combined Bomber Offensive over Western Europe during World War II, however, put paid to the notion of cheap and swift victory imagined by these air power theorists,[17] and the resultant victory over Germany was attained inch by inch using ground forces.[18]

The end of World War II heralded the beginning of the nuclear age, the Cold War and the missile era, each contributing to the advancement of the other two. Delivery of nuclear payloads was the next challenge to surmount and bombers became higher and faster, flying to evade AD, such as surface-to-air missiles (SAMs) and anti-aircraft artillery (AAA).[19] Missiles were developed to carry nuclear and conventional payloads into enemy territory. Surface-to-surface missiles (SSMs), such as intercontinental ballistic missiles (ICBMs), intermediate-range ballistic missiles (IRBMs) and short-range ballistic missiles (SRBMs), were designed to target adversary military and civilian infrastructure due to the lack of effective missile defence then. Over a period of time, with the increasing efficiency of AD, such as guided missiles, improved radars and longer-range anti-aircraft guns, the air force functions were split into specialised aircraft.[20] Interceptors, fighters, fighter-bombers, electronic warfare (EW), SAM hunters, all these meant that during a campaign, strike packages of aircraft became large, implying greater coordination, robust communication and a patterned and layered way of conducting operations. Effectively, counter-air campaigns meant to destroy enemy's air assets, AD resources and airfields were allotted the maximum resources, followed by counter-surface force operations (CSFO), which were essentially BAI, air interdiction and BAS. The attempt was to establish control of air through either air supremacy, air superiority or FAS, which could then enable ground operations to proceed with minimal opposition.

Today, modern aircraft are multi-role, combining the functions of strategic bombing, interception and air interdiction within the same platform; but control of the air still remains a foremost prerequisite. It is equally true that attaining control of the air, at least between near-peer competitors, is very challenging, especially as the fate of the surface operations hinges on this control.[21] It is to straddle these two diverging trends that the concept of

integral air support to land operations from a futuristic perspective has been envisaged. It integrates emerging technologies, such as off-board sensing and processing, image recognition, EW and artificial intelligence (AI), on readily procured and produced airframes to create significant quantities of attritable platforms which are scalable, affordable and reusable. The next section looks at certain contemporary case studies which focus on the relation between air support and ground operations.

Air Support and Ground Operations in Contemporary History

There was a major difference between the use of air power theorised in the United States (US) doctrines and the way it was practised during the Cold War era conflicts. These conflicts did not break out between the major superpowers but played out between countries in the so-called Third World. A major deviation in the theory, using nuclear strategy terminology, was the envisaged use of air power in counter-value targeting in the Western doctrine,[22] while air power was used extensively in counter-force targeting during these conflicts, where actors on the opposing sides were supported by the US and the Union of Soviet Socialist Republics (USSR). The 1967 Arab–Israeli War, also known as the Six-Day War, involved use of counter-air operations by the Israeli Air Force against the Arab nations' air assets on ground, which decimated the air forces of Egypt and Jordan and severely crippled that of Syria, with the first day of Arab losses reported to be 300 aircraft destroyed.[23] This enabled the Israeli Air Force to fully support the ground operations of the Israeli Defense Forces (IDF), facilitating their rapid advance. During the later phase of the 1971 India–Pakistan War, the Indian Air Force (IAF) planes flew a number of BAI and BAS sorties to support the Indian Army offensives; though the initial emphasis was on counter-air campaigns against the Pakistan Air Force (PAF) by targeting their runways and airfields.[24]

The 1973 Yom Kippur War between Israel and primarily Egypt and Syria focused on the suppression of enemy air defences (SEAD).[25] As per an analysis, in this war, close air support (CAS) had far less impact on the ground battle than either the participants or the observers anticipated. Some of the reasons included ground-based air defence weapon systems (GBADWS) and interceptors, inadequate target acquisition, lack of training and munitions lethality.[26] The same analysts also contended that long-range bombing failed to make the desired impact.[27] The 1982 Bekaa Valley operations were a fine example of air superiority operations involving the destruction of

reportedly 23 Syrian SAM sites, but involved almost a year of planning and were supplemented by artillery batteries firing in tandem with air strikes.[28] This operation could not, however, be deemed a success for the IDF as they suffered huge losses, with nearly 500 soldiers killed, more than 2,500 wounded and nearly 100 tanks and armoured personnel carriers destroyed in subsequent land operations.[29] The Gulf War was the culmination of a number of advances in precision targeting, stealth, extended reach, increased computing power and satellite communications, resulting in a demonstrably matchless performance which, more or less, decided the war in favour of the US-led alliance.[30]

The US air efforts in its various conflicts in Vietnam, Afghanistan and Iraq also need to be analysed in brief to bring out the challenges of using strategic air power. In Vietnam, the US Air Force (USAF) conducted a number of consecutive air campaigns. In Operation Rolling Thunder (1964–68), the target was the North Vietnamese Army's (NVA) air assets and later, GBADWS and AAA guns.[31] The Tet offensive of 1968 was the first time in the Vietnam war when US air power could actually affect the ground operations by hitting fixed NVA and Viet Cong (VC) positions.[32] In terms of air interdiction, the Ho Chi Minh trail was hit consistently and continuously throughout the war, but the impact was much lesser due to extensive foliage, effective integrated air defence system of NVA and VC tactics. Operation Linebacker and Linebacker II were a response to the 1972 ground offensive by NVA and made a huge difference to the defence by the South Vietnamese Army.[33] In Iraq and Afghanistan, during the counter-insurgency phase, the US air effort was not able to make much of a headway due to a widely dispersed enemy. Though there were admirable successes in the opening or the conventional phase in both theatres, these fizzled out once the US force settled for the long and protracted phase of guerrilla warfare.[34]

Integral Air Support to Land Operations

Traversing through the timelines, air power theories and case studies, there is a glaring issue that merits consideration, that is, integral air support to land operations. Though BAS and BAI are specific roles played by independent air power in support of land offensives and there are numerous examples of such a support in military history, the patterned layer of operations alluded to earlier means that the first priority of the air force is the control of air—long or short term is a matter of metrics. A dense AD environment, need for real-time ISTAR, networked kill chain of sensors, processors and shooters,

proliferation of unmanned platforms and short-range SSMs imply that land forces, apart from BAS and BAI support from the air force, will require integral air support to initiate operations, most likely in a parallel timeline to the air operations. Recent operations have demonstrated that attaining control of the air is not a given, with primacy likely to be accorded to air denial operations.[35] As evidenced by the latest analysis of the Russian air campaign in Ukraine, the Russian Air Force's (VKS) most 'influential failure' was to fail to find, fix and destroy the bulk of the Ukraine's GBADWS.[36] This was made possible by Ukraine shifting its AD assets continuously using shoot-and-scoot tactics—all due to the exceptional intelligence received from Western countries.

Douhet's contention that GBADWS would be the most catastrophic expense in a country's defence budget due to the necessity of defending everywhere has been turned on its head. Using a mix of S-300V1 (SA-12), Buk (SA-11), Osa (SA-8), Tor (SA-15), Igla, Strela and Stinger man-portable air defence systems (MANPADS), IRIS-T SLM AD systems, Gepard self-propelled anti-aircraft guns (SPAAGs) and Norwegian/National Advanced Surface to Air Missile System (NASAMS), Ukraine defeated VKS's SEAD and destruction of enemy air defences (DEAD) efforts, forcing Russian armour and artillery to fight without effective CAS and then using own networked shooters, such as artillery batteries and unmanned aerial vehicles (UAVs), to destroy them piecemeal.[37] In the initial months of the conflict, Russian SEAD efforts were reportedly more successful since they involved launching salvos of cruise missiles across domains at standoff ranges.[38] This was accompanied by EW to deter and degrade Ukrainian efforts at ISTAR. These actions and counter-actions on the part of the Russians and Ukrainians are portentous enough to warrant a deep think over the future of the conduct of joint operations and how emerging technologies can be used to provide integral and organic air support to land operations. In this case, it is imperative that technology is leveraged to ensure that integral air support to land operations proceeds in two prongs: ISTAR and kinetic operations.

Role of Emerging Technologies in Providing Integral Air Support to Land Forces

AD systems have continuously proliferated across the world. Supplemented by advances in EW, cyber and space, they have created 'denied environments' where the conduct of own operations will be heavily contested and/or denied

operational superiority or peer status.[39] This environment needs to be presumed while planning operations to cater for a scenario where CAS to land operations, as understood in the conventional sense, may not be possible. The most common form this takes is that of a GPS-denied environment,[40] where the primary means of guidance and targeting is denied. This has spurred the development of autonomous systems, powered by AI and connected through 5G networks, relying on edge computing and advanced sensors, such as light detection and ranging (LIDAR), to search, fix and destroy targets on their own, with minimal human intervention.

In effect, contemporary warfare features a combination of *technologies looking for platforms* rather than combat platforms waiting to be upgraded. The end result is that any object which fulfils rudimentary design specifications can be used as platform for integrating these technologies. Standardisation, modularity and inter-compatibility of numerous sophisticated commercially available off-the-shelf (COTS) products, such as gimbals, electro-optical lens, infra-red, multispectral cameras, post-processing software, real-time hyperspectral satellite imagery, has proven their utility on the battlefield. Imagining a leap from technology demonstration to rapidly scalable products capable of saturating the TBA requires dedicated effort and foresight, but the optimist part is that these are achievable in a shorter time frame than traditional platforms. The permutational capability of these technologies has been enhanced using large language models (LLMs), which eases the option of do-it-yourself (DIY) warfare. Initially limited to non-state actors, the ubiquity of powerful and cheaply available processors, sensors and software, and now LLMs, means that the latest technologies just need explosives and scale to graduate from technological demonstrators to full-blown armaments. Countries like Ukraine have demonstrated the battlefield utility of AI-equipped aerial drones that are finding and attacking targets without human assistance.[41] Similarly, drones made out of waxed cardboard have been fitted with high resolution camera and explosives and have been used against Russian airfields.[42] Edge processing has enabled the UAVs to power through enemy EW interference to reach targets, though these capabilities are still in the testing phase.[43]

Palantir, a data-mining, fusion and AI company, has introduced its latest offering: combining LLMs with classified data to create the world's first military chat and service bot. Using this AI platform (AIP), one can request data and order strikes from amongst a number of platforms either in the vicinity, orbiting or on their way to the target area.[44] Since the current batch of unmanned systems functions on the basis of either satellite

communication or radio communication from ground control stations (GCSs), the most common counter to this is spoofing or jamming. In fact, a recently leaked trove of Central Intelligence Agency (CIA) documents points to advanced Chinese capabilities involving using cyber weapons to hijack enemy satellites.[45] This development points to the success of the Chinese in creating additional war domains, such as space, EM spectrum and cyber, apart from traditional ones, such as land, air and water. The development of these capabilities has led to the US initiating a programme called Collaborative Operations in Denied Environment (CODE), which 'aims to extend the capability of the US military's existing UAS to conduct dynamic, long-distance engagements of highly mobile ground and maritime targets in contested or denied battlespaces'.[46] The CODE project attempts to build autonomy in its unmanned aircraft systems (UAS) on the basis that future operations will be held in highly dense AD and EW environment and that only autonomy is the way forward, an intent that has also been codified into its Third Offset Strategy.[47]

On the other hand, the USMC has shed its traditional outlook on fighting conventional wars. As per their ex-Commandant, General David Berger, it is looking at shedding 'vehicles, aircrafts and systems that the service can neither afford to procure or afford to sustain over their anticipated lifespans' in favour of 'unmanned lethal, low-cost, long-endurance combat aerial vehicles, unmanned lethal and non-lethal ground and amphibious vehicles, unmanned aerial, ground, surface, and underwater logistics vehicles/vessels, Mobile and rapidly deployable rocket artillery and long-range precision-fires, loitering munitions' and EW capability, among others.[48] The inference is anticipation of massive attrition for the USMC and therefore, the need and emphasis on rapidly scalable and replaceable unmanned platforms with autonomy built in, which can operate in denied environments. This is only the USMC's strategy for its integral air support and does not take into account the bigger contestation for control of the air, which will also be playing out simultaneously. The strategy also underlines the USMC's intentions to initiate operations without waiting for the air battle to play out to provide it certain advantages.

Another aspect which is equally important is the basic premise of air power being envisaged as a third dimensional force capable of bypassing the enemy's attritional deployments and able to strike in depth. The same aspect can also be simulated through the emergence of SSMs, short- and long-range rockets, UAVs and finally, cyberwarfare, which, if visualised out of its straitjacketed interpretation of being limited to the 'virtual' domain, is capable of creating

destruction effects similar to that of long-range conventional weapons, obviating long distances, as the usage of Stuxnet Trojan on Iranian nuclear centrifuges demonstrated. Acknowledging the importance of cyber as an important war domain, at one of the recent Army Commanders Conference, it was decided to operationalise Command Cyber Operations and Support Wings (CCOSWs).[49]

Swarms, defined as collaborative operations between fully autonomous systems, are the next evolution in warfighting. They herald the creation of a weapon system which combines mass, firepower and operational agility with minimal to no inputs from humans. Another concept is that of manned–unmanned teaming (MUM-T),[50] which involves combining the strength of humans and machines, transferring the cognitive load involved in repetitive and monotonous tasks to the machine and leaving the human to deal with creative decision-making. The Chinese People's Liberation Army (PLA) has conceptualised of unmanned operations as: swarm-style operations with volume and efficiency; stealth-based Trojan horse combat; intrusive lone wolf operations; unmanned autonomous operations; incapacitation combat; and marsupial drone/mothership swarm operations.[51] To operationalise these multiple variants of combat using unmanned systems, the Chinese are experimenting with what is known as Universal GCS, which can function on either of two foundations: one station control multiple machines or one station control multiple models.[52] While the former relates to similar machines with standard communication and data protocols, the latter is more ambitious in its intent with networking varied manned and unmanned platforms using the same GCS. This is similar to what the Americans are attempting with 'mosaic warfare', whose official term is Joint All Domain Command and Control (JADC2). It hinges on the Joint Warfighting Cloud Capability (JWCC), which is a Pentagon-wide attempt to connect sensors from all branches of the armed forces into a unified network powered by AI.[53] The next step should be distributed operations connecting sensors and shooters across multiple domains to neutralise adversary systems.

Another important yet underappreciated role of AI remains injecting or introducing chaos into a system. Here, chaos is referred to as any divergence from a patterned or predictive way of thinking, which is what the brain usually does when faced with a new situation. Just as AlphaGo played a seemingly 'inhuman' move against the then reigning Go champion Lee Sedol leading to a victory against Lee in the terminal stages of the game,[54] the ability of machine learning-based AI to create an intelligence separately from

the human-evolved one introduced chaos into the system. This can create battlefield advantages for friendly forces.

Coming to the Indian scenario, denied environment conditions will obtain on the borders, some less than the other. However, the likelihood of collusion between India's adversaries necessitates preparing for the most challenging of scenarios. As such, territory will form the centre point for any future conflict for India, affording the land forces the most critical of roles. This implies that apart from destruction of enemy platforms, there will be a need to sanitise and hold territory. Due to the dispersed nature of the battlefield, individual units and sub-units will require their own air support—an instrument which is affordable, networked, scalable, mobile and finally, capable of providing ubiquitous support in the form of ISR and kinetic action. Imagine a scenario where a number of mobile formations, each supported by autonomous UAS, hand or catapult launched and backed by short- and long-range SSMs, initiate operations in a denied environment. This can be backed by high-altitude long-endurance (HALE) and medium-altitude long-endurance (MALE) UAVs, with the air force conducting operations for control of the air. This provides the army with multiple options to create its own sanitised corridors, weaken enemy defences, aid in SEAD and DEAD efforts of the air force and conduct its own ISR, in conjunction with space-based assets. The Indian Army's efforts towards enhancing its integral air support, therefore, should move along three prongs: autonomous UAS; UAS swarms; and tactical ballistic missiles (TBMs).

While the immediate use of autonomous UAS will be to provide real-time ISR to the ground forces, in the medium to long term, they should be utilised for stealth and precision strikes on enemy mobile units, including personnel, artillery batteries, communication centres, logistics nodes, tracked vehicles and missile silos. Networked through 5G communication and undergirded by unhackable quantum cryptography communication links, these drones should be powered by edge processing and should have the ability to emulate the Indian Army's moral principles in its selection and destruction of targets. The mid-term solution can see the marsupial or the mothership concept in action, where a bigger drone or manned platform releases a cluster of mini and micro autonomous drones at a certain pre-programmed location. These drones can then proceed for target neutralisation. The UAS swarms can function either through imitation of animal behaviour or can form part of multi-domain swarms.

Interestingly, some of these concepts have already been test-bedded by the PLA. In 2019, China's Zhuhai Ziyan UAV Company displayed a 10

unmanned helicopter drones swarm in Turkey,[55] while the Electric Power Institute of China Electronics Technology Group Corporation conducted trials of land–air synergised multi-domain fixed-wing UAV swarms in October 2020.[56] Apart from the primary task of CAS, the UAS swarms can be used for additional tasks, such as AD, SEAD, DEAD, BAI and air interdiction. The last prong of Indian Army's triad of integral air support is units of TBMs, which can be used, as part of an Integrated Rocket Force (IRF), for DEAD, BAI and BAS exclusively for the army. The induction of additional units of Pralay quasi-ballistic missiles is a step in the direction of the creation of this force.[57] The Indian Army has also inducted two sets of swarm drones for surveillance and close reconnaissance, as per news reports.[58]

Prioritisation

The capabilities envisaged for the successful conduct of future warfare require discarding of some carefully held and nurtured notions of how wars are supposed to be fought. Technology will be the overwhelming factor and, in fact, will take the driver's seat in future war. This future is not too far off. However, it is equally important to acknowledge the limitations of a bureaucratic system, its nitty-gritties, and that there will be a considerable time lag between the conceptualisation and operationalisation of these capabilities. It is, therefore, necessary that certain technological capabilities be left to be developed by government labs, agencies and the private sector, while the Indian Army focuses on its key tasks. The foremost priority is communication and networking of disparate assets. This requires consultation and coordination for creating standardised data, communication and cyber protocols and implementing them across the army, in conjunction with any theaterisation mandate.

Legacy platforms must be connected to each other through data links and these must be treated as systems with certain characteristics, such as firepower or ISR, with the capability for one-on-one replacement with other systems of similar firepower or ISR capabilities. This is the ultimate success for a system wishing to create and operate multi-domain capabilities. The Indian Army must procure UAVs as fast and rapidly as possible since one of the most discernible advantages of a UAV is, ironically, its expendability. The procurement drive can take the form of handholding in-house projects from academia and the private sector. In fact, in an ideal situation, networking and procurement should proceed in parallel directions. Two sets of swarms have already been procured by the army and more need to be done in the near

future. For 5G communications and quantum communications, the army, through the Department of Military Affairs, should request for test-bedding its equipment on the government's 5G infrastructure[59] and under the purview of the National Quantum Mission respectively.[60] Airspace management is another major challenge that will arise out of the need for identification and deconfliction. Finally, indigenous chip design for edge processing through start-ups needs to be started. This can be undertaken by the Army Design Bureau through the Innovations for Defence Excellence (iDEX) challenges.

Conclusion

Independent air power, through its reach, speed and mobility, has played and continues to play a major role. However, due to the increasing density of enemy air assets, AD resources, EW, cyber and EM spectrum capability, control of the air is neither a given nor possible for an extended period of time or space. In these contested environments, there is a necessity for land forces to have their integral air support elements in the form of autonomous UAS, swarms and TBMs in their inventory. Most of these capabilities are potent only if they can be scaled with standardised protocols and modular components. These have to be networked, encrypted and ruggedised in order for land operations to have a compatible interconnectivity with air operations being conducted at the strategic level as well as joint capabilities, such as space, cyber and EM spectrum.

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