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FIGHTING FUTURE WARS

A ROADMAP FOR ADOPTION OF DISRUPTIVE TECHNOLOGIES IN THE INDIAN MILITARY

AN AERIAL PRACTITIONER'S PERSPECTIVE

AIR COMMODORE K.A. MUTHANA

About the author

Air Commodore K. A. Muthana (16372) Flying (Pilot) was commissioned in the Indian Air Force as a Fighter Pilot in the flying branch on 11 June 1981. A graduate of the National Defence Academy, the officer has over 3000 hrs of total service flying. The officer is a Qualified Flying Instructor (QFI) and an Experimental Test Pilot (ETP). He has held several key command and staff appointments including that of a Qualified Flying Instructor, Test Pilot and Test Flying Instructor (TFI), Flight Commander and Commanding Officer of a fighter sqn, Project Test Pilot of an Aircraft Upgrade Project, Director of Aircraft Upgrade at Air HQ and Chief Ops Offr of a frontline fighter base.

As a graduate of the Defence Services Staff College, he holds an MSc degree from Madras University. He ensured very high training standards as a QFI and as a test pilot performed several key trials. For his performance as Flight Commander (10) of a front line fighter Sqn, he was commended by the Chief of Air Staff in 1996. While on deputation to HAL (Nashik Division) as Chief test pilot he ensured very high standards of production. In 1999 he was selected to command the first Bison Sqn of the IAF The officer's vision and effectiveness directly contributed to the creation and sustenance of world-class infrastructure for a new type and also achieved a 100% safe flying record. The officer was then handpicked as the project test pilot for the Sukhoi Upgrade programme and was instrumental in ensuring the development of a potent fighter platform for the IAF As Chief Operations Officer of a frontline fighter base he managed to directly oversee runway repairs and induction of the Sukhoi aircraft while continuing unrestricted operations in a very busy civil aviation hub. The officer was appointed to command a frontline fighter base in January 2008.

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Introduction

Experience during the past year on India's northern borders would have forced the decision makers in its national security establishment to carry out a reality check on several strengths and weaknesses in the domain of warfighting across the spectrum of conflict. Several conclusions and recommendations would currently be flying across the corridors of power, particularly in areas of technology where India's northern adversary holds a significant advantage. India, with its vibrant democracy and federal system, has its own strengths and weaknesses when attempting to empower its armed forces as compared to what is possible by an authoritarian single party regime. That must not, however, prevent it from capitalising on the strengths of a democracy and initiate a wider discourse on how technology can be leveraged to think about and fight future wars. This article offers a practitioner's perspective on the opportunities and challenges facing India's defence R&D establishment and military industry as they emerge as pivotal elements in an India that is seeking self-sufficiency in high-end technology to support capability building in its armed forces.

Economic Power and Power Games

Leading powers of the world are once again engaged in a struggle for global supremacy. This time around, it is a rising power, China, which appears to have learnt from the mistakes of the Soviet Union and is playing the game differently. The Soviet Union collapsed not because it did not have weapon systems in quality and quantity to wage war, but because its economic model was unsustainable. China is not making the same mistake and has been shoring up its broader economy for decades while concurrently adding muscle to its war fighting capabilities. After convincing major western players in the high-tech industry to relocate manufacturing to China, it has managed to convince or coerce its partners to transfer technology and facilitate reverse engineering. This has galvanized its own industrial revolution and helped China emerge as the major trading partner of several countries of the world including much of the developed world. Although Chinese mass-produced goods were the butt of many jokes in the past, it is no longer so today. China has emerged as the major supplier of semiconductors and rare earth raw materials/finished products to the world. The global electronics industry the world over would be majorly affected if the Chinese decide to cut back or scale down its production of semi-conductors and rare earth raw materials. As its economy grew, it started allocating increasingly large resources to military research and development. Today, the People's Liberation Army Navy (PLAN), is the largest in the world; its space-based capability is fast catching up with that of the U.S, particularly in the realm of C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) and space situational awareness. It has operationalised a mind-boggling array of unmanned air vehicles in the last decade; its AI technology is poised to overtake that of the US; its indigenous weapons arsenal is cutting edge; its stealthy fighter aircraft is operational and its current declared defence budget is three times that of India. It is unlikely that India will be able to withstand the technology barrage launched by China if it comes down to a full-fledged multi-sectoral conflict. In such a scenario, it is imperative that India embarks on strategy to leverage technology to reduce the asymmetry with its northern adversary, particularly in areas that will strengthen deterrence and allow the latter to respond effectively

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and raise the costs of conflict for an adversary who enjoys significant technological advantage. The long-held bogey of the suspect quality of Chinese war machinery and disadvantages that the People's Liberation Army Air Force (PLAAF) faces due to the high elevation of airfields in Tibet will be mitigated by other means such as putting in place a lethal air defence network and developing technology-intensive soft-kill options that would lead to network disruption and much more. It could well be argued that prospects of unacceptable cost in human lives, precipitated in no small measure by the resolute riposte offered by the Indian Army with admirable support from the Indian Air Force (IAF) in the recent Eastern Ladakh crisis, has made China pause and agree to a partial de-escalation. Militarily, this appears to only be a strategic pause. Considering that even the U.S. is worried about China's ascending prowess and is scrambling to retain its technological superiority, the signs are ominous for India unless it embarks on the strategy of leapfrogging and attempting to bridge the yawning technological gap that has emerged between the two Asian powers.

Chinese strategic interests in South Asia are primarily driven by economic and geopolitical interests with an overlay of restoring historical legacies. It actively seeks to secure the maritime route of its Belt and Road Initiative, possibly an easier access to Pakistan Occupied Kashmir for the CPEC, and access to Indian markets through RCEP or otherwise. India refusing to accede to the above, along with the several internal developments in India that China sees as inimical to its own interests, like the abrogation of Article 370 in J&K and the creation of the Union Territory of Ladakh, seem to be the primary reason for the pin pricks or attempts at salami slicing on India's northern borders. For the present, India would be well advised to actively participate in the Quad initiative while vigorously pursuing the dream of a five trillion-dollar economy by 2024. Adequate funding of defence R&D, both in the public, but more importantly in the private sector is fundamental to India achieving military balance of power in the long term and consequently, peace.

Scientific Mindset in Decision Makers

If one were to chart progress of the human race from its evolution about 200,000 years ago in East Africa, through the agricultural revolution 12000 years ago, the scientific revolution 500 years ago, the industrial revolution 200 years ago and to mankind transcending the boundaries of planet Earth routinely today, one would realise the potential of exponential growth in human scientific ability. If political and strategic decision makers were to attune their minds to thinking and planning for exponential technological progress, many bombastic pronouncements would be followed with concerted action, a facet that is singularly absent within the Indian politico-military-bureaucratic-industrial complex. The stream of domestic committees and leaders who visit design agencies/ factories, are immensely impressed with demonstrations of 20th century technology, and make statements about how advanced our factories and products are, is typical of the gap between hype and reality. It is time, however, that empowered and responsible technocrat political appointees or specialists drive innovation in the military, rather than generalist bureaucrats or entrenched members from the established scientific establishment who have a significant turf to protect.

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Trajectory of Technology in Aerial Warfare

The canvas of conflict across which an adversary could wage war in the future would be far wider than direct action between formal military forces. It could be at the limits of one's imagination, like merchant ships leaking fuel outside harbours, to stoking internal unrest or disrupting power supplies, stock markets etc. While asymmetric scenarios will have to be war gamed with the latest technological tools like Artificial Intelligence (AI) and the emergent solutions deliberated carefully using the ingenuity of the human mind, the ensuing arguments will be restricted to brainstorming actions against a future external adversary by integrated forces, with a concentration on the application of force by fixed wing offensive air forces.

Combat Cloud

Two important reports by Steve Trimble in aviationweek.com in December 2020 are instructive to take this narrative further:[1]

- In September 2020, USAF airborne sensors fed targeting data to US Army's mobile howitzers which shot down a surrogate cruise- missile target with a BAE Systems hyper-velocity projectile.

- In a history-making experiment by the U.S. Army, in late October, the crew of a Boeing AH-64E Apache used a sensor to identify a target on the ground and a laser designator to mark its location, then fired a missile to destroy it. Such an outcome may seem routine for the Army's premier attack helicopter, except in this case the target was miles beyond the sensor and missile ranges of the Apache. The experiment required three aircraft. An RQ-7BV2 Block 3 'Shadow' flew far ahead of the AH-64E, scanning terrain beyond the horizon of the Apache crew. After using the Shadow's sensor and laser designator to fix the target, the AH-64E crew commanded a missile firing from the wing of an MQ-1C Gray Eagle Extended Range UAS, which was also positioned ahead of the Apache. Three days later, the same three aircraft collaborated to hit a target with a Dynetics GBU-69 Small Glide Munition.

To prosecute a future war, it is necessary to build infrastructure that ensures the ubiquitous and seamless connectivity of all sensors and shooters in a particular theatre, both airborne and on the surface. Hopefully such an AI augmented connected battle space would have been one of the initial capabilities sought from our Defence Communication Network (DCN) that was deployed in 2016. Ensuring resilience of this network would also be of vital importance by ensuring adequate hardware and software redundancies. The hardware would include a constellation of satellites in different orbits, High Altitude Pseudo Satellites (HAPS), terrestrial elements and manned/unmanned aircraft that can be launched quickly to cover gaps, should they emerge. Satellites can be knocked out by kinetic and non-kinetic means. Capability for 'on-demand' launch of satellites into Low Earth Orbit (LEO) must be built. Solid fuel motors of ISRO/New Space could be launched within 24 hours. Even faster launches can be operationalised if capability is brought on to the Su-30 MKI aircraft. Small satellite launches

[1] Trimble, Steve. "Autopilot". Aviation Week — December 21-January 10, 2020.

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would be definitely feasible with a solid motor rocket. Higher specific impulse could be achieved with liquid fuel motors, though sloshing of liquid fuel due to aircraft dynamics may affect launch dynamics. This problem would have to be overcome. A launch from a Su-30 would have additional advantages of being able to launch from above weather and even from over the equator where the saved fuel could be used to achieve higher orbits or reduced weight of the launcher or increase payloads. Such capacity can be expanded if capability is brought on to a transport class of aircraft. The newly formed Defence Space Agency (DSA) has much ground to cover in this realm. HAPS is an ongoing program and must be hastened. Concurrently, as these projects see the light of day, the Defence Cyber Agency (DCA) also has its job cut out. Though there will be no guarantees to ensure the security of software, there must be the ability to recover quickly from attacks by having dynamically reconfigurable software. Deterrence must be part of such plans too as the world moves well beyond deterrence from physical attack. This is best achieved by building offensive capability and demonstrating it occasionally, as allegedly done by the Russians in the Solar Winds hack or allegedly by the Chinese on the Mumbai power grid. One can only allege in such shadow wars even though the fingerprints are obvious.

Internet of Military Things (IOMT)

Having set up the combat cloud, the next step would be to equip sensor/shooter elements with software defined radios (SDR) compatible with datalinks, and thus create an internet of military things (IOMT). Currently, IAF aircraft are being equipped with SDR. Ideally, compatible SDR must become standard equipment on all weapon platforms of the Indian Armed Forces. Only then can we achieve ubiquitous and seamless connectivity enabling maximum compression of the sensor-to-shooter loop. It is easy to forget an important element in IOMT, weapons. Suitable family of weapons must be considered an organic part of the carrier platform during the design stage itself. All smart weapons must have a compatible datalink and become part of the IOMT. Since the IAF is in the process of equipping aircraft with SDR, the problem of dealing with legacy network equipment should not arise, except in a very few cases, where it would be prudent to just use them as such. With the setting up of the Department of Military Affairs and the institution of the Chief of Defence Staff, it is time now for a top-down flow of directives mandating the equipping of all weapon systems with compatible datalinks for them to play their role as a thing on the IOMT. How sophisticated and how resilient can the IOMT be is a matter for the managers of the DCN to decide. How to operationalise the IOMT is a matter of conception, wargaming and implementation.

Artificial Intelligence

It is important for the military leadership and for war fighters in the armed forces to understand both the strengths and limitations of Artificial Intelligence (AI). According to Andrew Ng, who has held leadership positions both at Google and Baidu, progress in leaps and bounds is being made in Artificial Narrow Intelligence (ANI) which in short is performance of tasks, and not much in Artificial General Intelligence (AGI), which again in short, is performance of jobs. AGI is the arena wherein AI tries to compete with the human brain, and again according to Andrew Ng, AI surpassing the human brain may be decades, hundreds or even thousands of years away. In the pursuit of usable ANI, it is the war fighter who understands his/her needs. These needs will be different for warfighters in different Services. So, one of the functions of the Defence AI Council (DAIC) must be to form permanent sub-councils to garner requirements from the services and have them brought to fruition in the Indian private sector. The program managers and product managers must be from the Services. They must be the technologically savvy practitioner pivots who will translate the warfighter's requirements in suitably modified language to AI engineers in the private sector. They will also coordinate operationalisation of AI in various facets of warfare. One of the fundamental requirements for effective AI is big data. Some types of data will be difficult to come by and the process will be time consuming. So, the earlier one starts, the speedier will be the outcomes that flow from such initiatives. There is also a need to emphasize that the hardware must also be indigenous with no roadblocks to continuous evolution of a product to a family of products. Equally important, there is a need to put in place the wherewithal and knowledge to certify AI and maintain quality control.

A Possible Air War Scenario

During typical offensive air actions, friendly air forces are expected to encounter varied platforms from opposing air forces and surface to air missiles in the physical domain. In the non-physical domain, there would be electronic attack and cyber-attack. Therefore, the fundamental characteristics of friendly lead elements must comprise a wide-spectrum low observability with weapons that have longer kill ranges than those launched from competing adversary platforms. These lead elements could consist of optionally manned fighter aircraft (which will be manned for quite some time, in the authors opinion) teamed with Unmanned Air Systems (UAS). UAS could be flying ahead of the fighter aircraft and be equipped with sensors/jammers and/or weapons. Varied tasks for UAS could be to detect and jam/soft kill enemy sensors, infuse virus into enemy systems, saturate enemy defences and execute hard kill/suicide missions. Such UAS have also been referred to as attritables since they are supposed to be low cost and either recoverable or expendable.

The leading elements of the manned aircraft package could keep their active sensors quiet and delay detection. Stealthier the leading manned elements, the deeper they will be able to penetrate along with UAS and fire higher impact weapons that could significantly damage an adversary's combat potential. Into such an airspace, once it is depleted of defences, would penetrate in numbers, non-stealthy aircraft to complete the mission objective. One development project for such a teaming system is known to be underway in the public sector. To infuse competition and agility in such development, R&D funding by the government to both public sector and private sector is essential. The most critical gap in the IAF inventory today is the absence of a stealthy fighter/ bomber aircraft. It would be foolish to try and penetrate state of the art air defences with non-stealthy aircraft. Hence, the Advanced Medium Combat Aircraft (AMCA) program must be the highest priority for indigenous design and manufacture. Another point to ponder over is about India's ability to strike the centre of gravity of its adversary in the North. They are so deep into the hinterland that none of India's combat aircraft can attempt to reach there with much hope of success even if they undertake air to air refuelling in own territory. Only option would be to fall back on surface-to-surface missiles. Employing adequate number of missiles with conventional warheads will be prohibitively expensive. More weight of attack could be delivered repeatedly by stealthy long range bomber aircraft. Such aircraft would also facilitate carriage of hypersonic weapons and/or be able to generate enough power for offensive Directed Energy (DE) weapons. Planners would do well to consider.

DNA of Next Aircraft Design

"We've already built and flown a full-scale flight demonstrator in the real world, and we broke records in doing it," Will Roper, former US Assistant Secretary of the Air Force for Acquisition, Technology and Logistics told Defense News in an exclusive interview on 14 September 2020. "We are ready to go and build the next-generation aircraft in a way that has never happened before." This aircraft was built using the "holy trinity" of digital engineering, agile software development and open architecture, Roper said. This news shocked the aviation world. The entire exercise is supposed have taken less than two years. This was the second fully digitally engineered aircraft to be flown by the US industry after the T-7 Red Hawk trainer. Compare this to the history of the largest fifth generation aircraft fleet, the F-35. Its experimental version X-35 flew first in year 2000; first test flight of one operational model, the F-35A was in 2006; and this model was introduced into service in 2016. Our own Tejas LCA flew first in 2001 and the first IAF Tejas squadron was formed in 2016. In stark contrast, in a digitally engineered aircraft most of the test flying is also done in the digital world and the first physical model comes almost ready for production, thus washing off more than a decade in development time and money.

Why is this important? Technology usable by the military is progressing at such breakneck speed that it is impossible to predict its state beyond about five years. So, as we continue to do now, if we take more than two decades from conception to service induction, technology at induction would be about three generations behind. The defence services will continue to be blamed for constantly changing requirements and therefore, precipitating more delay. Another pain point is the process of upgrading aircraft to meet emerging requirements. On one such aircraft, the conception to contract signing to operationalization took 10 years. On another aircraft, it is being conceived for the last 15 years without fruition of any final decision. Due to the sheer pace of technology, such lack of agility in the future would be unaffordable on any parameter. Here once again the 'holy trinity' can come to the rescue. The US plans to roll out at least one new model of an aircraft every about five years. The total life of each such model is expected to be no more than about 15 years. They call it the 'digital century series'. If practicable, and there is no reason why it should not be in the US at least, it would be a wonderful concept. Digital engineering would do away with costly hardware like jigs and fixtures reducing design and manufacturing costs, there would be no need for major overhaul, and every five years or so there would be new technology up for exploitation.

Whether India can emulate this model is a moot point. What is essential, however, is that India must design and build the AMCA and UAS in Industry 4.0 facilities. This must be a non-negotiable mandate given to the developers. Necessary funding must be provided, and foreign partnerships sought for Industry 4.0 technology. This is as important as our intention to produce a new fully funded fighter jet engine with help from Rolls Royce. Late last year US Air Force also demonstrated a capability to upgrade mission system software on an airborne

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fleet. For those who understand the ramifications, this is huge. Till now, adding a new application or updating an old one was a long, cumbersome, and expensive process involving months of extensive regression testing.

Sensors and Weapons

Other areas that need significant work are sensors, pointing devices and antennae. 100% of inertial navigation systems on IAF fighter aircraft are imported. Attempts have been on for long to indigenize, but it is unlikely that the main sensor in the unit will be indigenized. 100% of India's laser designation systems are imported as are its helmet mounted sighting systems. The list goes on. The country of origin of these equipment may also be a problem when attempts to export platforms are made. Upgrades and re-equipping involve protracted contract negotiations and are also very expensive. Attempts to indigenize in the government sector aim to only match existing equipment and not to better them as a passion to lead is sorely lacking. That is why it is so important for the government to fund big ticket R&D in the private sector and spare no other effort in acquiring sensors' technology. As long as Intellectual Property (IP) rights are retained in India, there should be no limitation as to what method is used. Also, companies with IP on sensors should be bought out by Indian companies.

Weapons are an area where India fares better. Except for Brahmos, all operational Precision Guided Munitions (PGM) and Air to Air Missiles (AAM) on the IAF arsenal are presently imported. However, many indigenous weapons are in the development phase. As mentioned earlier, if a particular weapon needs a data link, it must be made compatible with the larger combat cloud. There is feverish activity in the world on development of hypersonic weapons with various kinds of propulsion systems. Additional kinetic destruction value and difficulty in intercepting them are the primary advantages of such weapons. These are bound to be relatively large, and their carriage must be factored into new aircraft design. Initial DE weapons are likely to be primarily for self-defence against incoming missiles. On legacy aircraft, these are likely to be podded, thus occupying one station on which weapon load could have been carried instead. Large power and cooling requirements must be factored in when internal self defence equipment is planned on new design aircraft.

Another fundamental requirement on low observable aircraft are conformal antennae in various bands. Indigenous research, development and manufacture of high quality, low loss conformal antennae that are capable of aiding stealth, is also need of the hour.

Budgeting for Technology

Among the prime challenges in this narrative are the challenges of budgeting and resource allocation. India's Defence Acquisition Procedure (DAP) keeps evolving every other year, and the last release was on 30 September 2020. In the R&D arena, formation of Innovation for Defence Excellence (iDEX) organisation and establishment of the Technology Development Fund have been commendable steps. These, however, only cater to small ticket items R&D in the private sector. When it comes to large ticket items, courage to bite the bullet and invest

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large sums for research, innovation and process development have been sorely lacking. It is old wine in new bottle and perpetuates mediocrity. Of specific interest to discerning policy makers in the defence technology space would be Chapter IV on Procedure for Acquisition of Systems Designed and Developed by DRDO/DPSU/OFB. The most important piece of equipment that would enable the IAF to fight future wars, the AMCA, will be procured under provisions of this chapter. While leading powers of the world would be feasting on the fruits of digital engineering and agile software development, we are likely to repeat the LCA saga at least in timelines. R&D and manufacture will not happen in the time of relevancy. Although Para 7 (c) of the chapter states "If the prototype is not developed within the agreed timeline, SHQ may acquire the weapon/equipment/platform through other procurement categories/procedures with approval of AoN according authority", such approval will never be accorded and even if accorded, we would have lost years wherein a better approach would have yielded better results. Funds for R&D programs get approved by the Cabinet Committee on Security (CCS). Programs stretch for more than a decade. As long as some progress is shown on the program, there is little accountability on whether the program itself is relevant or not, or whether it is necessary to revector. Long winding justifications are put up which wind through multiple laterals and verticals to reach the CCS after many months. The review and monitoring mechanism is also weak and toothless.

Even the LCA had higher monitoring levels, with the apex committee being chaired by the Chief of Air Staff and occasionally, even by the Raksha Mantri (RM). All that happens is that review of power point presentations will start 10 days before quarterly reviews, 25 persons will travel to Delhi, meeting will last for three hours, and 25 persons will travel back. By the time minutes of meeting arrive, slipping back to status quo has already happened and the program will progress at the same pace. In the process, the warfighter is left capable of fighting the last war or resorting to *jugaad* (improvised solutions). We must get innovative, creative, and courageous with large ticket projects also and force the DRDO/DPSU to compete with private entities in the R&D arena. A variant of strategic Partnership model elucidated at Chapter VII of DAP 2020 must be used. Phased R&D funding, as iDEX does for small ticket items, must be provided to both parties and the completed test products must be evaluated fairly to decide the winner whose product would go into production through Buy (Indian-IDDM) process.

Management of Technology Development Programs

Who will manage such a competition? It must not be the MoD. There is inadequate informed oversight on functioning of the three departments of the ministry of defence (DMA is very young and DESW does not count here). If one studies the saga of LCA Tejas from 1985 to present times, one will understand. Nothing much has changed in the areas of monitoring, accountability, and deliverable deadlines with suitable penalties. Though sceptics like the author will argue that given a chance, much innovation for the AMCA is likely to come from the private sector, to be fair, there have been pockets of excellence in output from DRDO. Its Integrated Guided Missile Project (IGMP) that delivered the Prithvi and Agni class of missiles and the flight control programs for the LCA have been outstanding. There would, however, be a lot more bang for the buck and value for the war fighter if DRDO is forced to compete for technology development funds along with the private sector. Thus, there would be no conflict of interest also as to whom the development work is being assigned.

As a possible structure to monitor programmes like the AMCA and other big ticket future military technology programmes, it is suggested to create a Department of Defence Technology (DoDT) under the PMO. Its core manning would comprise experts in various technical fields laterally inducted from outside including from the Indian diaspora. Warfighters may be sent there on deputation for effective liaison with parent services. There would be nothing secret about technology that India could develop for a long time as it would merely be playing catch up for a while. What would be secret is the level of its adoption by the military, its deployment and operational philosophy. DoDT must be empowered and tasked with running phased, fully funded R&D competitions between private companies, public companies, and government laboratories under various ministries, to develop different high technology hardware and software that would enable the Indian armed forces to fight the next war. Production rights must be given to the winning developer for which all must identify their production partners beforehand. Not involving production agencies at the design stage, itself is one of the fundamental mistakes that we make. A level playing field must be ensured either way. For example, government funded test facilities must be made available to all. Similarly, many freedoms available to private companies should be allowed to government entities too for specific projects. As stated before, as long as IP rights remain in Indian owned companies in India, there must not be any restriction on which politically acceptable company in the world they partner with.

The DoDT must have its organic certification and quality control set up for R&D. This is essential because the existing ones comes under different departments in the MoD and by themselves are a bottleneck for reasons both within and beyond their control.

Conclusion

Enabling India's armed forces to fight the next war and prevail will only be possible if there is meaningful reform in the higher defence R&D management among other transformational initiatives. Agile and responsive budgeting and funding for innovation is an imperative in a rapidly evolving military technology arena. Focus of such reform must be to form an expert empowered and adequately funded body specifically to drive indigenous high ticket, high technology hardware and software product development for adoption by the military. Such a body must be under the PMO and could be manned only by lateral entry of experts from the private sector including Indian diaspora. Phased R&D competitions that are open to all, must be fully funded. Foreign partnerships must be encouraged, but all IPR must be retained in India. The aim of development must be to enable the Indian military to operate ubiquitously and seamlessly on resilient AI enabled combat clouds where all sensor shooters are things on the IOMT. Coming specifically to the air element, the priority should be to rapidly develop manned/optionally manned/unmanned low observable platforms that have a chance to penetrate enemy defences and deliver adequate and accurate weight of attack. Need of stealth bombers merits consideration. Weapons in the PGM/hypersonic/DE class must be considered organic parts of aircraft that would be developed. All development and manufacture must be in Industry 4.0 facilities. The Holy Trinity of digital engineering, agile software development, and open system architectures must be adopted fully to drive down costs and enable rapid development.

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