Centre for Air Power Studies

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IMPACT OF TECHNOLOGY ON AIR WARFARE

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The impact of technology cannot be overstated in any discipline, especially in air warfare, an entity that was created by technology. Air has long been used to gain an advantage over an opponent, whether it was observation via simple balloons or addressing a target thousands of miles away with the precision of point-blank range. However, the nature and tenets of warfare technology will always have the greatest impact on air warfare, the most important of which is speed, which necessitates the shrinking of the Observe, Orient, Decide, and Act loop (OODA).

Unlike earlier technologies like nuclear weapons, stealth, or precision capability, which proliferated slowly, the emerging technologies will spread quickly and create new paradigms. The relationship between quality and quantity, for example, is constantly changing as a result of technological advancements. While precision weapons reduced the number of aircraft over the target, low-cost swarms have brought mass back to the battlefield. In 2018, the tech company Intel flew 2,018 drones at once in Folsom, California.[1] They were participating in a light show there, hence were equipped with lights but could very well be armed with ammunition instead.

Interplay between Strategy and Technology

Is it technology that drives strategy, or strategy that drives technology? According to some analysts, technology is merely an enabler, and what matters is how strategists use it. Without a doubt, technology cannot function on its own; it must be implemented with a purpose, but this should not reduce it to a lesser being or a secondary status. The status of technology is on par with the status of strategy. If the pursuit of a faster weapon solution resulted in the development of hypersonic technology, the advent of GPS evolved the strategy of GPS-aided targeting. If the need for persistent surveillance

led to the development of long endurance unmanned platforms, the availability of quick reaction small drones is driving the strategy in the ongoing Russia-Ukraine conflict. As a result, strategy and technology are inseparable and intertwined in such a way that they complement one another. In a two-wheel drive, the question of whether the rear wheels drive the front wheels or the front wheels drive the rear wheels is relevant; in a four-wheel drive, the question becomes irrelevant.

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Purpose of Technology in War

The fundamentals of war have not changed. The aim still remains to win a war quickly. The purpose of technology is to assist in the achievement of that aim. Whether it involves the physical destruction of a target or the electronic degradation of the power grid, or conversely, the prevention of it, technology has a role to play. Technology is needed to reduce the adversary's decision-making time and aid you in making quick decisions. Some of the fast-emerging technologies that need serious attention are – hypersonic, artificial intelligence/ machine learning (AI/ML), quantum, and cyber.

Hypersonic Technology

Hypersonic is defined as a speed that exceeds Mach 5, which is five times the speed of sound. This speed regime is not new to mankind, satellites move at Mach 20+, and ICBMs reenter at similar speeds; it is the hypersonic cruise missile, like Kinzhal, a Mach 10 missile launched by Russia from MiG 31 against Ukraine,[2] that is going to be a game changer. Supersonic cruise missiles, like Mach 3 Brahmos, are relatively easy to achieve, but Mach 10 is a challenge. The manoeuvrability of difficult-to-detect-air-breathing hypersonic cruise missiles in the atmosphere has completely changed the dynamics of the threat, apart from the shock and awe they can generate. There will be hypersonic UAVs tomorrow.[3] Not only quick but credible decisions will be a necessity. Who can assist with that?

Artificial Intelligence/Machine Learning

Artificial intelligence and machine learning are emerging as powerful tools for making more timely and credible decisions. AI/ML algorithms can provide real-time information and recommendations to pilots and commanders, allowing them to make informed decisions in fast-paced and dynamic situations. In addition, these algorithms can aid in the planning of complex missions by taking into account factors such as aircraft and weapon capability, enemy threats, weather, fuel consumption, and so on.

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Drones outfitted with AI/ML algorithms can fly and navigate autonomously without any human intervention. They can detect and identify potential targets, analyse data, and make decisions independently. In addition, AI/ML tools can scan vast intelligence, surveillance, and reconnaissance (ISR) data quickly, which is vital for planning and conducting operations that would otherwise be humanly impossible.

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Since AI applications are algorithm-intensive, do they pose a challenge? Contrarily, algorithms are not the most complex aspect of AI architecture. Algorithms are based on a set of mathematics, the majority of which is perhaps centuries old, explains Dr. Ian Levy, Technical Director of the UK's National Cyber Security Centre.[4] The most complicated aspect is the data that drives it. Like experience is the training for human beings, the training for AI is data - a large amount of data on our shared values from various disciplines.

All of the applications of AI mentioned above will require a large amount of data on aircraft, weapons, missiles, radars, terrain, weather, and so on. As a result, the practitioners will have to take part in wargames and numerous simulations before trusting it on the battlefield. But, of course, AI tools will still go by the rules, and there are no rules on the battlefield. And the challenge is that all the AI applications and their simulations will require not only data but also real-time updates and superfast processing of this huge data. And how will that be accomplished? This is where quantum technology will come into play.

Quantum Technology

Quantum computing has the potential to improve air warfare by allowing for faster and more accurate data processing and analysis, which in turn is required for faster decision-making. Quantum sensing and quantum illumination techniques can detect stealth aircraft.[5] Gyroscopes based on quantum sensors could provide more accurate positioning, navigation, and timing (PNT) information in a GPS-denied environment.[6] Quantum communication, based on quantum mechanics principles, makes communications impossible to intercept or eavesdrop on.[7] It is important to note, however, that quantum technologies are still in their early stages of development, with many technical and practical challenges to overcome before they can be deployed in operational contexts.

Cyber

Cyberwarfare has emerged as a major concern for many modern militaries. All the information for warfighting and the consequent strategy is in the form of data. Hackers

have the ability to infiltrate computer systems, disrupt military operations, steal sensitive information, and launch coordinated cyberattacks. Any amount of capability in space, air, or ground is vulnerable if the cyber that enables that capability is not protected. The cyber domain in warfighting has evolved in such a way that the threat must be addressed before the capability, similar to how you must plug leaks before filling up a pool. While cyberattacks require a high degree of understanding of the systems being targeted, they do not necessarily require significant resources to conduct. The barrier to entry is relatively low, and cyberattacks can be contracted out to private groups or individuals.

India must achieve autonomy in detecting and neutralising drones by incorporating AI/ML functions that can distinguish between birds, helicopters, planes, and drones.

Cyber operations, in terms of espionage and countermeasures, are just one part. The cyber domain has thrown up different kinds of challenges. For example, a cyberhacker has the potential to render a commander ineffective in warfighting by stealing their digital identity. As technology becomes more embedded, one's digital identity will supersede their physical identity to become your primary identity. No one will be able to function without it. One can be barred from participating in any operations or decision-making chain. No one is going to take orders on the phone; they will all be digital, and without digital access, one will be rendered non-functional, amounting to digital murder.

Warfighting heavily relies on computer networks, communication, and data transfer. Any intrusion or disruption attack, or even mere scepticism of it, can throw operations out of gear. One would require internet resilience. The network's supply chain, therefore, must be given special consideration. The United States Army has requested a software bill of materials (SBOM) for its network, which is a list of the components that comprise an application or a system, allowing evaluation of a piece of software's or an entire system's origins, vulnerabilities, and risks.[8]

India's Status and Way Forward

India successfully tested the scramjet-powered Hypersonic Technology Demonstrator Vehicle (HSTDV),[9] which can travel at Mach 6. Furthermore, at the NSA level meeting on the sidelines of SCO, India and Russia discussed the possibility of the joint development of a hypersonic version of Brahmos, to be called Brahmos II.

India raised the Defence Cyber Agency, which must look into cyber security aspects while all services are vulnerable to cyberattacks. Recently, a homegrown operating system, BharOS, has been developed by a private company, JandK Ops, incubated by the IIT Madras Pravartak Technologies Foundation.[10]

The government has approved the National Quantum Mission to nurture and scale up scientific and industrial research and development in quantum technology. The mission involves a cost of Rs 6,003.65 crore from 2023-24 to 2030-31.[11]

India must achieve autonomy in detecting and neutralising drones by incorporating AI/ML functions that can distinguish between birds, helicopters, planes, and drones. A drone catcher with its own electro-optic (EO) device or even a radar onboard, in some cases, is a possible solution. India must also overcome the biggest challenge to technology.

Developing new technologies is expensive, and the government will certainly need private sector collaboration, even in R&D... Even when quantum technology seems like a distant reality, the cabinet's nod for the National Quantum Mission sends just the right signal.

Biggest Challenge to Technology

If new technology is a challenge, incorporating new technology is an even bigger challenge. The most difficult challenge to incorporating new technology is not its complexity; rather, the most formidable adversary of technology is its adaptation.

Fearing the lack of data that would drive AI, an expert committee under the UN, in a meeting on September 20, argued for strict control and a partial ban on autonomous weapons. It said that autonomous weapons posed a serious risk to global security. Moreover, it was argued that even the best AI isn't well suited to distinguishing farmers from soldiers and may be trained only on laboratory data, which is a poor substitute for real battlefields. The Secretary-General tweeted, "Autonomous machines with the power and discretion to select targets and take lives without human involvement are politically unacceptable, morally repugnant and should be prohibited by International Law."[12] A little over two years later, the United States is developing a self-flying F-16 under Project Venom,[13] in order to refine an AI engine capable of flying a wide range of current and future aircraft.

Invariably, people are nostalgic about legacy and stay in that comfort zone. However, technologies like AI/ML and quantum take time to mature, and ten odd years in technology development is not long. If you start thinking about it when it's on the horizon, it's already too late. Developing new technologies is expensive, and the government will certainly need private sector collaboration, even in R&D. The private players in the defence sector must believe that the leadership is seriously interested in new technologies and that investing in them is worthwhile. Even when quantum technology seems like a distant reality, the cabinet's nod for the National Quantum Mission sends just the right signal.

Notes:

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