Essay

Disruptive Technologies and India's Military Modernisation

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Armed forces must always be capable of accomplishing their primary mission of fighting and winning wars in the land, air and sea with capabilities they have trained with and for which they have necessary sustainment. At the same time, the military must anticipate new threats and technologies and seek capabilities needed in the event of future conflicts. An increasingly globalised international system and rapid acceleration and diffusion of commercial and military technologies into military applications may disrupt the power balance. Emergence of disruptive technologies has lowered the barriers for many small and developing states and even non- state actors to acquire and field advanced military capabilities or inexpensive but highly effective asymmetric ability.

Given India's declining defense spending, persistently low investment in R&D, an archaic and weary acquisition system and a small defense industrial base, there is a need to examine how emerging game changing disruptive technologies are shaping the security environment and India's military modernization strategy. India's policy makers need to identify some key disruptive technologies and step up research and development as a significant value addition to transform the existing indolent modernisation effort.

Threat Concerns

India faces complex threats and challenges that range from nuclear to sub conventional spectrum of conflict and interminable calibrated terror attacks. Unresolved territorial disputes with China and Pakistan, increasing footprints of China's Navy in the Indian Ocean, insurgency in Jammu and Kashmir and in the North Eastern states, left

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wing extremism and rising threat of urban terrorism, add up to India's security concerns.

China has clearly emerged as the most potent military threat. Growing military, economic and technological strength of China and its global footprints is impacting the strategic environment the world over and is cause of serious security concern for India. China is on a course to transform itself into a strong military power because of its government's ability to direct investments to the defense sector from its large economic resources. China's approach to funding its defence requirements has been deliberate and substantial. China's military spending increased by an average of 10 percent (inflation adjusted) per year over a period of two decades. Official defence budget, average 1.4 percent of GDP, is more than four times India's defense budget. And this does not include the budget set aside for R&D, equipment maintenance and other subsidies to military personnel. China R&D allocation has grown to 20 percent of world's R&D budget. Earlier known for cloning Western technology, China has taken a leap ahead in developing a formidable defense industrial base through acquisitions of most effective platforms from abroad with transfer of technologies, retrofits, targeted foreign direct investment, and theft of intellectual property. China has set up R&D Apparatus (RDA) to further its conventional capabilities in an `*informationalised*' battlefield and force multiply it by identifying and maximizing the utility of emerging and potentially bleeding edge disruptive science and technology for military use. An example is the operationalising of the J-20 stealth fighter and its simultaneous leapfrog to the hypersonic wave rider vehicle programme.

China is the largest and assured exporter of advanced conventional military hardware such as combat aircrafts, AD system, radars, precision guided rockets, drones, tanks and other military equipment to Pakistan at subsidised rates. In addition, China is actively assisting Pakistan in setting up its defence industrial base. China has recently signed a contract to sell eight submarines to Pakistan. Of these, four would be made in Pakistan. In addition to pursuing upgrades in ballistic missiles and other conventional platforms and systems, Pakistan is reported to have set aside significant national effort in developing disruptive technologies such as cyber, information warfare (IW), artificial intelligence (AI) and unmanned autonomous systems.

Commercially accessible technology advancements can be adapted for military use to advance disruptive objectives. Off the shelf available drones have been weaponised by ISIS and used as a potent hybrid threat. India is susceptible to non-state actors accessing advanced disruptive military equipment from Pakistan or China to

disrupt communication, surveillance, or used for long range guided fires. With China focused on military transformation and force structuring that blend with the revolutionary changes in military technology, including disruptive technologies; the nexus between China-Pakistan and Pakistan-non-State actors, demand urgency in India's military modernisation programme.

Modernisation Goal

The objective of modernisation is to close the capability gap against the extant threats and provide qualitatively improved capability against future threats. Though our armed forces are capable, our competitive edge against China is adversely widening and narrowing with respect to Pakistan. Decades of deferred modernisation have resulted in a force that is obsolescing. Maintaining fleets of ageing ground systems, aircrafts and ships is becoming prohibitively expensive. Our armed forces are struggling to develop the capabilities necessary for modern *informationalised* warfare. The modernisation has to thus focus upon a vision for the future and the challenges in balancing near, mid and far term investments. This would entail upgrading hardware, breakthroughs in transformational technologies, innovation, design, development, indigenous manufacturing base and refined acquisition process. To achieve desired effectiveness, it must be fused with appropriate organisation and structure, joint service concept of operations, tactics, command and control, readiness, sustainability and supporting infrastructure.

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The Indian Armed forces must adopt a multi-pronged strategy centered on technology and innovations. In the near-term, the armed forces need to invest in capabilities that address critical gaps and improve lethality to expand and fill the capability gap against contemporary competitors. Primarily it must address readiness shortfalls. In the mid-term, the Armed forces develop, procure, and field next generation capabilities with some bleeding edge technologies like AI, EW and robotics, cyber capabilities, integrated as value add-ons in multi-domain *informationalised* hybrid battle space. In the far-term, we need to build for a fundamentally different conflict environment – one that will require us to operate with host of new cutting edge technologies that are likely to change the way military equipment is designed and the way military forces will fight. Future battle space is likely to see command being

exercised across dispersed and decentralised formations leveraging disruptive technologies even at small unit level, all at an accelerated speed of war.

A balanced modernisation strategy requires both disruptive and capability based incremental innovations to provide defence capabilities in all time horizons. While mature technologies solutions act as enablers in near term, a combination of mature and some future disruptive technologies, nearing full maturation, will address emerging threats in medium term. In the long term, matured disruptive technologies will create a new paradigm in which the level of performance would exceed the limits of traditional conventional evolutionary innovations and will also radically enhance the performance of existing products.

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Cutting Edge Disruptive Technology

Under what is being termed as the third offset in the field of military technology, the revolution in military affairs (RMA) is proceeding to a new stage. The first offset technology products were built through the post-World War II, Korean War, Vietnam War and the Cold War period. The second offset technology systems were influenced by breakthroughs in ICT and precision-guided weapon systems/platforms. Their application manifested during the Gulf War. Military applications of emerging from the third offset cutting edge Science and Technology include robotics and autonomous unmanned system, hypersonic, new undersea systems, artificial intelligence, nanotechnology, EW, stealth meta materials, information and big data analytics, cognitive neurosciences, quantum technology, additive manufacturing, 3D printing, energy and propulsion, directed energy weapon, and cyber capabilities. US, China and Russia are pursuing military innovations driven by these advances and integrate them into 'intelligent' military systems. A brief of some of the new technologies, which are being pursued with intensified focus and are likely to get integrated with the high end second offset technology driven weapon platforms are as under:

1.**Directed Energy Weapons**. High- energy (H-E) lasers have been under development for many years. They offer the potential of enabling low cost, speed of light multi shots, thereby increasing the likelihood of destroying tactical and strategic targets. The challenge has always been how to deliver enough energy focused at the right spot on the target. Advances in solid and liquid state lasers have increased the prospects for practical weapon applications. DARPAs H-E Liquid Laser Defense System (HELLADS) programme

is developing a 150 KW H-E laser weapon system with a weight of less than 5 Kg/KW. This will enable UAVs to carry HELLADS closer to the intended launch point of hostile weapon system/platform. Advanced directed energy weapons (DEW) like H-E lasers, high power microwaves could be used to reinforce air defense systems to shoot down drones or as ship borne anti missile system. Such DEW leverage speed as well as reusability of these weapons. In conjunction with autonomous systems, operational tempo can be dramatically increased at tactical and operational level. At the strategic level, subsequent progression of H-E laser development into multi- hundreds-of–kilowatts level will make missile defense applications more feasible and enhance BMD capabilities against missiles with nuclear warheads. This would be a source of uneasiness to major nuclear powers.

2. **Artificial Intelligence**. Artificial Intelligence(AI) has become a reality and would act as a force multiplier for future military capabilities. With the help of AI, machine learning and big data analytics, analysis can be produced with greater efficiency and speed at reduced cost. AI impacts intensely on passive surveillance operations wherein the sensors are not looking for an object in the noise but rather AI is being used to find a hole in the noise that would indicate the presence of an object. This would apply to anti -infiltration, anti- submarine and anti- air warfare. AI has numerous security implications when combined with other technological developments related to offensive military operations. China is pursuing to become the premier global AI innovator by 2030, with a goal to surpassing the U.S. in the process. In this, the PLA seeks to advance and research, develop, and test a range of military applications of AI like employing machine learning, including deep neural networks, to enable rapid processing of data and imagery in support of intelligence analysis. Advances in swarm intelligence could enable autonomous unmanned asymmetric assaults against high-value weapon platforms such as aircraft carriers. Looking forward, a revolution in military affairs could be anticipated wherein AI will be as integral to future warfare, as information technologies have been to '*informationalised*' warfare.

3. **Hypersonic Strike Technology**. Hypersonic refers to speed regimes of five times the speed of sound (Mach 5) and higher. Recent advances in areas of materials technology, guidance, control, and propulsion systems have started to address exceptional thermal, pressure, and other technical challenges of hypersonic weapons. The concerns about hypersonic weapons are that they are difficult to intercept because of the speed and maneuverability. Combined with high accuracy and non -nuclear warhead, it will become possible to launch a hypersonic weapon from a stand off platform against adversary missile silos and other hard targets with little warning without crossing nuclear threshold.

The kinetic energy alone of the hypersonic weapon will create an equivalent explosive yield against the target even if it carried no warhead at all. Hypersonic weapons lead to a very compressed time-line for decision-making. We don't have effective defenses against hypersonic weapons because of the way they maneuver and at the altitude they fly. India's whole defensive system is based on the assumption of intercepting a ballistic object. The potential for operational and strategic disruption over the next two decades against hypersonic weapons has to be factored into a long- term modernisation plan.

4. **Quantum Technology**. Quantum technologies are likely to become a source of radical disruption in military affairs. China is building world's largest quantum facility. One of their plans is to achieve by 2020, quantum supremacy with computing calculation power of one million times that of all existing computers in the world. Such computers could be used for code breaking of existing networks. At the same time, quantum communication technology enables un-hackable quantum networks. In 2017, China tested the world's longest and most sophisticated quantum key distribution network for ultra secure communications between Beijing and Shanghai and this is deemed ready for deployment in the military, government and financial sectors. Likewise, quantum meteorology, which measures small variations in physical parameters with unprecedented accuracy, will improve submarines stealth operations. A submarine with quantum navigation system could operate underwater for more than three months without the need to surface for positioning satellite signals. Such cutting edge disruptive technology will render a number of existing systems not worth the scale.

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5. **Autonomous Weapons**. Autonomous and semi- autonomous systems have already revolutionised intelligence, surveillance and reconnaissance (ISR). Unmanned aerial vehicles (armed/unarmed) are already in active service. Underlying technologies that support autonomous systems, like robotics, AI, software and wireless systems are developing rapidly. The shift to unmanned system will get accelerated once the tag, track and target technologies further mature and get linked to other ISR developments. China has reportedly tested the worlds first amphibious drone boat. Chinese military analysts claim that it could be used in land assault operations and is capable of forming a combat triad with aerial drones and other drone ships.

6. **Low Cost Persistent Sensing Technologies.** Today and into the foreseeable future,

a significant number of satellites owned by government and private entities, producing high-resolution imagery, are transmitting 360 degree pole to pole near continuous coverage. Greater availability and lower costs of satellites, improved inter satellite coordination, advent of swarm drones designed to seek out targets having potential to change, advances in sensor and other technologies, coupled with AI and big data analytics, potentially can cause severe disruption to strategic platforms and other value targets of interest by maintaining continuous monitoring capabilities. Such a capability to maintain and track silo based targets and more importantly maintain a track of mobile strategic platforms and value conventional forces like strategic reserves has implication on deterrence operations.

7. **Cybersecurity Threats**. Cyber-attacks, known since mid-1990s, are continuously evolving to extract sensitive information and denial of service/ access to physically sabotaging equipment. Such attacks are very difficult to attribute to a particular country, group or person. Being financially cheaper makes cyber attacks attractive to weaker adversaries. Cyber attack abilities to affect a wide range of technologies and activities make this a multi-dimensional threat. Cyber offence will certainly be a prominent feature of future warfare and combined with other emerging technologies be a disruptive feature.

Challenges to India Military Modernisation

Outer-space, cyberspace, AI induced autonomous unmanned systems, hypersonic platforms, quantum technologies in fields of computing, communication, sensors have become new commanding heights. Many of these new technologies like sensors and smart devices; creation of sophisticated information networks; growing potential in automated systems and AI, advances in electronics, big data analytic, quantum technology applications, advance manufacturing are largely the product of commercial development and driven by private sector. The challenge is not only to integrate these advances into military systems but also align the acquisition system, budgeting and manufacturing base. The innovation cycle for many of these technologies are much faster than traditional military programmes.

Past ways of thinking, organising, and executing have limited our ability to keep pace with technological development and our potential adversaries. The speed of change in warfighting concepts, threats, and technology is outpacing current Army modernisation. While our Armed Forces modernisation programme is engaged in a protracted struggle with the Defence Procurement Procedure (DPP) and bureaucratic

antibodies, China is integrating second and third offset technologies into military capabilities at an alarming rate. Unless action is taken soon, prospects of increased military risk –that of the inability to deter conflict and suffering unacceptable casualties in warfare is a distinct possibility.

The major challenges to defence modernisation are declining defense budgets, two decades of primary focus on low intensity conflict, deferring modernisation programmes, reinforcing the long-drawn-out acquisition system under a DPP document which is not supported by an appropriate Ministry of Defence structure, low commitment to private sector in defence manufacturing, and contemptible performance of defense PSU's, Ordnance factories and DRDO.

However, the bigger danger to our military modernisation in the long run is the very low fiscal and national commitment on R&D in cutting edge disruptive technologies. The three Services have credible capability development strategy and plan to address readiness shortfalls. They are thus largely focused on procuring/developing weapons systems/platforms emerging from second offset technologies to upgrade their capacity to utilise information in warfare and upgrade C4ISR system, mobility and strike abilities in all domains under the Long Term Integrated Perspective Plan (LTIPP). Historically, the armed forces will resist investment in technologies that call into question preferred legacy platforms, core competencies and concept of operations. The armed forces requirements, even without setting aside requisite budget for on the horizon disruptive technologies, far exceed the present national capacities. China on the other hand has made significant progress in inducting indigenous state of art second offset technology driven weapon systems/platforms and simultaneously made massive investments and notable advances in strategic/tactical support assets under third offset. By the end of 2030, when our modernization plan peaks with state of art weapon systems/platforms with second offset technologies, China is likely to induct third offset technology systems which can seriously disrupt the application/functions of our current and in pipeline modernization inventory.

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Way Forward

1. Fiscal pressure is forcing MoD to modernise incrementally; an uneconomical approach that does not address the threat holistically. The present defence

budget is barely servicing the committed liabilities under capital procurement. And what is being procured is mid/ high- end second offset technology weapon systems/platforms, which may deter the adversary for a decade or so. There is need to enhance the budget under the capital head by additional allotment and reducing revenue expenditure by restructuring the military. Government should adopt innovative initiatives like issue of defense bonds to raise money for long-term modernization and R&D in third offset defense/dual use technologies.

2. **Identify Changes in Battlespace:** During the next decade, diffusion of advanced technology, including the exponential growth of unmanned and autonomous robotic systems, power of data mining, additive manufacturing, DEW, will dramatically alter the offence-defence balance. The policymakers should think about disruptive technologies that have implications in particular in respect to China. Under the National Security Advisor (NSA), a Next Tech Office (NTO) could be set up to assess the implications of emerging technologies on future warfare. NTO should conduct series of wargames by bringing together military professionals, planners, policy makers, scientists, engineers, investors, ethicists and lawyers from variety of backgrounds to debate and identify impact of game changing technologies on future battlespace. The wargames should be progressive and the attendance and conduct be dictated by the unique aim set for each wargame. System Analysis, Modeling and Simulation Group at national level with relevant tools must assist such exercise.

3. **Defense R&D**. The private sector in India is reluctant to invest in under explored defense R&D because of associated financial risks and delay in government decision-making. R&D organisation and S&T institutes are tightly bound by financial, administrative and rules and regulations which is not conducive to innovative efforts. In such a scenario, the State invests over 85 percent in defence R&D largely through the Defence Research and Development Organisation (DRDO). The DRDO budget is a meager 5 percent of the defence budget of which not much is set aside for fundamental and applied research. The barriers in the existing realities need to be converted into enabling conditions by a concurrent top down and bottom up approach. The top down approach would involve operationalising the Defense Technology Commission under the Defence Minister. Under this umbrella organisation, an Office of Emerging Technologies, Advanced Project Agency, Research

Institutes of Technology Excellence and Joint Interagency Policy Committee should be set up as recommended by various committees. The top down focus would be capacity-building based on NTO recommendations for selection and acquisition of key technologies, convergence of assets and build economy of scales as a national mission. The bottom up approach should be based on a new business model to exploit entrepreneurship and innovation of technology SMEs which are nimble and can rapidly develop new technologies and prototypes of products based on such technologies. Such companies can hire specialist foreign and domestic consultants to acquire critical technologies and could seek equity participation by major manufacturing companies in India and venture capital companies. These companies should be given access to use DRDO facilities and other government labs on preferential terms. Once this model stabilises, experts from the DRDO and other government labs or Public Sector Undertakings could join these R&D companies on a sabbatical.

4. **DRDO:** The only organisation, dedicated as military technology provider, needs to be reformed as suggested by the Ravindra Gupta Report in August 2012. DRDO should be reconstituted as Defense Technology Commission on the lines similar to Atomic Energy Commission and Indian Space Research Organisation (ISRO). They should concentrate on core high technology areas leading to advanced technology weapon systems and platforms and should move out of low peripheral areas by offloading to industry. DRDO should adopt a techno-globalist approach by pursuing avenues of joint research and development with countries like USA, Russia, France, UK, and Israel. For this, offsets and other strategic spin offs can be leveraged. DRDO's biggest challenge is attracting, nurturing and retaining talent. It is advisable to maintain a lean DRDO organisation having career scientists only for overall project management and source outside talent for specific projects on relatively short term contracts of say 5-7 years. Research, especially in emerging disruptive technologies could thus be supported by young scientists/ start ups, with confirmation for longer period depending on performance.
5. **Defence Industrial Base**: Globally, many of the new technologies with defence applications are being driven by the private sector. Proliferation of sensors and smart devices; creation of sophisticated information networks; growing potential in automated systems and AI, advances in electronics, big

data analytic, quantum technology applications, advance manufacturing are largely the product of commercial development. We have undertaken no known large-scale national effort on breakthrough in dual use technology. China is building world's largest quantum facility with a budget of 76 bn Yuan as against only Rs 3 billion sanctioned to five researchers of Indian Institute of Science and Technology(IISER). The defence industrial base is not taking off in the absence of contracts. The private sector is reluctant to invest in under explored defence R&D because of associated financial risks and delay in government decision-making. The government has to carry out a surgical strike on the non- performing DPSUs. As a first step, it should adopt a Public-Private-Production (PPP) model. It should also encourage MSMEs to provide technology, especially dual use technology, by enhancing the technology development fund and assured purchase of success on a spiral development mode.

6. **Ministry of Defence (MoD)**: Compounding the low fiscal allotment for R&D and product development in emerging cutting edge dual use technologies is the challenge to integrate these advances into military systems. The innovation cycle- time for many of these technologies is much faster than traditional military programmes. The MoD structure is not aligned to the acquisition system, production policy, budgeting and manufacturing base. There is a functional disconnect between users, R&D organisation, production agencies and the decision makers in the MoD. Each agency functions in vertical silos under rigid channels of command. Under the present MoD structure, any amount of amendments to DPP, Defence Production Policy and Expert Committee reports are exercises in reinforcing failures. With third offset disruptive technologies on the horizon and China leapfrogging to compete with the USA to integrate these into military applications, the urgency to transform the MoD structure is mandatory for a balanced modernisation to happen in all time horizons.

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Conclusion

Modernisation strategy identifies the ends needed for the Armed Forces to accomplish its future mission. The process organises the ways and aligns the means for

using the resources and activities of the nation's science and technology capacities, capabilities development, acquisitions, and promoting enterprise and indigenous defence industrial base to mitigate tactical, operational, and strategic risk across all time horizons. Disruptive innovations are often viewed as radical challenges to existing technologies and initially fail to meet military requirements in short/mid term horizon. The customer tends to initially under invest and mismanage technologies that are likely to become mortal threats in future. Currently, India's modernisation drive is focused on upgrading existing second offset weapon systems and platforms and that too with insufficient budget. However, most of the disruptive technologies have dual use and are being driven by commercial entities. An overarching national mission to identify the needs and congruence of products into military applications, must form part of armed forces modernisation strategy.