HYPERSONIC GLIDE VEHICLES VERSUS BALLISTIC MISSILES: IMPACT ON FUTURE WARFARE

AJAY KRISHNA MISRA

CHANGING FACE OF WARFARE

The face of technology-based warfare has been seen to be changing, whether it was the Cold War bout between the USA and USSR or the present era confrontation between the US and China. The hidden expressions of these players were based on a deterrence-based reasoning[1] through the development of nuclear warhead carriage vehicles, hopping from strategic bombers in World War II to Intercontinental Ballistic Missiles (ICBMs) in the Cold War era, and presently moving to hypersonic weapons. The initial approach of developing military technology as a nuclear deterrence strategy has been reborn in the recent past and is evolving as a true symbol of power for certain players.

In the present destabilising multipolar world, the threat envelope has grown with advancements in ICBM technology, but the pressure has expanded to the geo-engagement space with the development of hypersonic weapons,

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Group Captain **Ajay Krishna Misra**, VM, is a fighter pilot of the Indian Air Force with 3,000 hours of flying. He holds MSc and M Phil degrees in Defence and Strategic Studies. He is presently posted at Headquarters Integrated Defence Staff.

1. "The Theory of Military Deterrence Was Based on a Simple Psychological: Critical Reasoning (CR)," https://gmatclub.com/forum/the-theory-of-military-deterrence-was-based-on-a-simple-psychological-141552.html. Accessed on March 27, 2022.

especially Hypersonic Glide Vehicles (HGVs). This article will be deliberating on the technological advancements in the field of hypersonic weapons and ballistic missiles with an aim to uncover the impact of these threats on future warfare.

A rocket-based launch capable of carrying and delivering the weapon from outside the atmosphere resulted in the development of ballistic missiles.

UNDERSTANDING MISSILE DEVELOPMENT

The capability to propel a weapon towards an intended target, though based on the Mysorean rockets,[2] emerged as a larger threat in the form of the German V1 and V2 rockets in World War II.[3] This threat grew in its forms through the development of various types of missiles having different trajectories, speed profiles and manoeuvring capabilities. The existing missile options can be classified based on the above-mentioned characteristics and are as discussed below.

Missile Trajectory

The developments in rocket as well as jet engine technology, along with guidance systems, resulted into two projectile options for the developers.

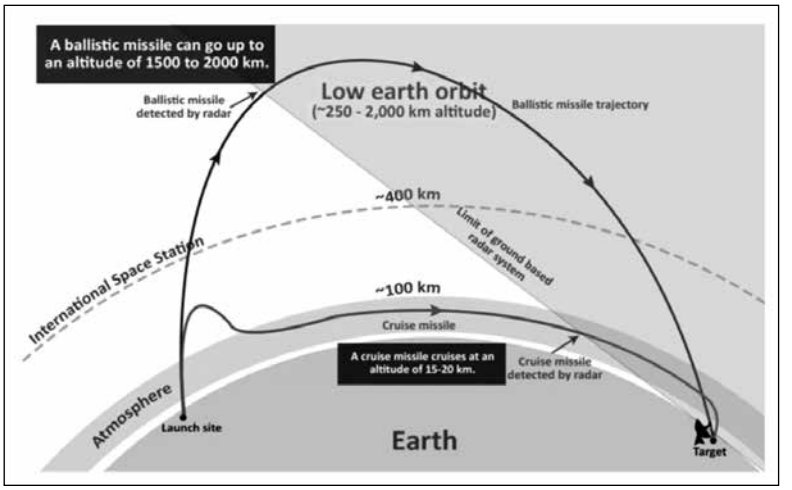
- **Ballistic Missiles:** A rocket-based launch capable of carrying and delivering the weapon from outside the atmosphere resulted in the development of ballistic missiles. Such missiles travel in a projectile motion and their trajectory depends on the rocket boost capability, gravity and air resistance during reentry. These missiles are classified based on ranges, including short range (<1,000 km), medium range (1,000-3,000 km), intermediate range (3,000-5,500 km) and intercontinental range (>5,500 km).
- **Cruise Missiles:** A jet engine-based powered missile, having control surfaces and inbuilt navigation, resulted in the development of cruise

2. "Tipu Sultan and His Mysorean Rockets: The World's First War Rockets," https://www.thebetterindia.com/119316/tipu-sultan-mysore-rockets-hyder-ali-first-war-rocket/. Accessed on March 28, 2022.
3. "V1 and V2 Rockets - ETHW," https://ethw.org/V1_and_V2_Rockets. Accessed on March 28, 2022.

missiles. These missiles follow a comparatively straight trajectory towards the target while remaining within the Earth's atmosphere. The shorter path results in the missiles being mainly of the short-range class (<1,000 km). These missiles, coupled with comparatively better terminal guidance systems, achieve higher accuracy compared to ballistics missiles. The flatter trajectory of a cruise missile, as seen in Fig 1, results in delayed detection of cruise missiles compared to ballistic missiles.

The parabolic trajectory of ballistic missiles, though achieving high impact speed, had the challenge of predictable path and early interception.

Fig 1: Trajectories of Ballistic and Cruise Missiles



- **Missile Speed:** The development of ballistic and cruise missiles provided certain unsuitable balances between missile path predictability vs missile speed. The parabolic trajectory of ballistic missiles, though achieving high impact speed, had the challenge of predictable path and early interception. On the contrary, a cruise missile flying a low altitude trajectory, had the advantage of late detection but the limitations due to

the propulsion system and thermal heat resulted in the missile travelling at subsonic speeds and, thus, facing the challenge of interception by terminal defences. This led the developers to explore the options of accelerating the missile into the regimes of supersonic (1.2 to 5 Mach) and hypersonic (5 to 10 Mach) weapons.

- **Missile Manoeuvring Capability:** The developments in the field of anti-ballistic missile defence[4] as well as terminal phase Close In Weapon Systems (CIWS) created an additional hurdle against these long range missiles. This resulted in the development of the Multiple Independently Targeted Reentry Vehicle (MIRV) for ballistic missiles[5] and multi-point navigation in cruise missiles[6] which provided the manoeuvring capabilities to these missiles in the terminal phase.

The long development phase, available with both the attacking and the defending players resulted in suitable counter-options being developed and available with adversaries. This resulted in severe implications on the desired nuclear-based deterrence strategy achieved especially through ballistic missiles. This loss of grip necessitated decision-makers, thinkers and scientists to mitigate the limitations in ballistic as well as cruise missiles, and work towards a new option.

HYPERSONIC WEAPONS: THE NEW OPTION

The analysis of present anti-missile defence systems, whether against ballistic or cruise missiles, guided designers to develop weapons whose path cannot be predicted, and which are fast and manoeuvrable in the terminal phase. The unpredictable aspect demanded development of a non-ballistic

4. "NATO-Topic: Ballistic Missile Defence," https://www.nato.int/cps/en/natohq/topics_49635.htm. Accessed on March 28, 2022.
5. Richard A Hartunian, "Ballistic Missiles and Reentry Systems: The Critical Years," https://minutemanmissile.com/documents/ReentryVehicleDesignAndPhysics.pdf. Accessed on March 28, 2022.
6. Multi-point navigation in cruise missiles: The developments in missile navigation systems have enabled planners to plan multi-point changing direction paths towards the target so as to degrade the enemy's interception capability.

missile limiting itself within the Earth's atmosphere. The development in the supersonic air breathing propulsion system started in 1960 by Weber and MacKay,[7] provided the solution of developing hypersonic weapons travelling within the Earth's atmosphere. These high speed missiles have challenged the decision-making cycles and command architecture, thereby again pushing the attainment of the deterrence-based objective.

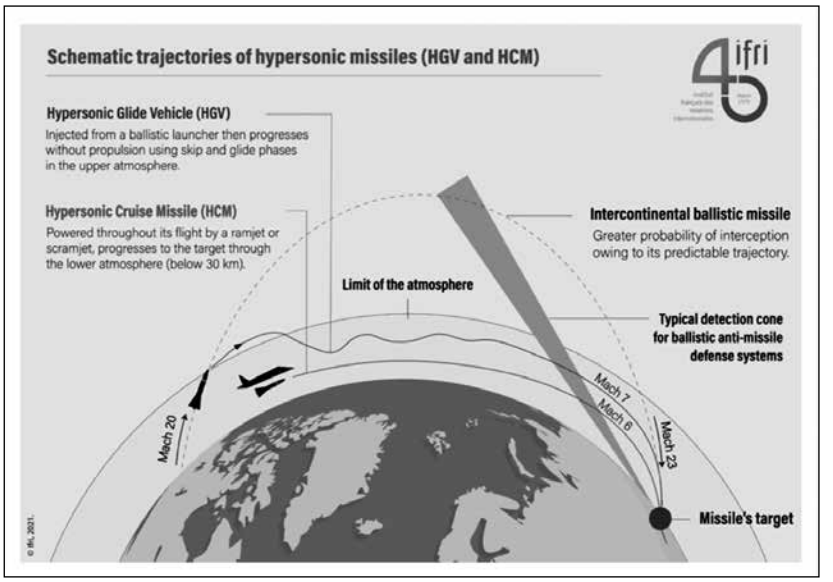
The air breathing propulsion system, including the 'Ramjet, Scramjet and Dual Mode Ram Jet (DMRJ)',[8] can operate the weapons within 50 km of the Earth's atmosphere. However, these propulsion systems require the initial boost to achieve speeds required to operate the scramjet or similar propulsion systems. These capabilities, when combined with the advancements in the field of materials, sensors and autonomous operations[9] have resulted in the development of two hypersonic weapons, including the Hypersonic Powered Cruise Missile (HCM) and Hypersonic Boosted Glide Vehicle (HGV). The classification of these hypersonic weapons can be well understood through a comparison of the powered mechanism, trajectories and terminal manoeuvring used in these weapons.

- **Propulsion System:** HGVs are carried on multi-stage rockets and separate from the mother vehicle during the climb phase, and are injected into the upper Earth atmosphere (>50 km). This initial boost is utilised subsequently by these weapons to glide in an unpowered state towards the target. HCMs, on their part, are carried by multi-stage rockets, and post separation, undertake a powered flight utilising scramjet/DMRJ propulsion systems towards the target.
- **Missile Trajectories:** HGVs, post separation, follow an alternating ballistic phase with skip/glide manoeuvres towards the target, remaining

7. J. Swithenbank, "Hypersonic Air-Breathing Propulsion," *Progress in Aerospace Sciences* 8, no. C, January 1, 1967, pp.229–294, https://doi.org/10.1016/0376-0421(67)90005-X.
8. Isaac Lopez, Thaddeus J Kollar, and Richard A. Mulac, "Use of Commodity Based Cluster for Solving Aeropropulsion Applications," *Parallel Computational Fluid Dynamics, 2000*, 2001, pp.123–129, https://doi.org/10.1016/B978-044450673-3/50084-1. The increase in flight speed beyond supersonic profiles was achieved through developments in propulsion techniques and the same has been explained in the document.
9. John Hopkins and David M Van Wie, "Hypersonics: Past, Present, and Potential Future," *APL Technical Digest*, 35, no. 4, 2021, www.jhuapl.edu/techdigest.

within the Earth's atmosphere. Whereas HCMs, while remaining within the Earth's atmosphere, follow a comparatively straight path towards the target.

Fig 2: Trajectories of Ballistic Missile, HGV and HCM.[10]



- **Terminal Manoeuvring:** HCM weapons, being in a powered state, can execute comparatively higher levels of evasive manoeuvres and navigation amendments. HGVs while gliding at higher levels within the Earth's atmosphere, also have adequate energy levels in the terminal phase and can also undertake evasive manoeuvres.

WORLD LEVEL POWER PROJECTION: BALLISTIC/CRUISE/ HYPERSONIC MISSILES

The global power in recent times, has been switching technologically supported hands through various developments in the field of ballistic/ cruise/hypersonic missiles. Table 1 lays down certain key initiatives

10. "Hypersonic Weapons: What Are the Challenges for the Armed Forces?" | IFRI (*Institut Français Des Relations Internationales*), https://www.ifri.org/en/publications/briefings-de-lifri/hypersonic- weapons-what-are-challenges-armed-forces-0. Accessed on March 29, 2022.

undertaken in the field of ballistic/cruise/hypersonic missiles at the global level.[11]

Table. 1: Ballistic/Cruise Missiles, HGVs and HCMs with Major Powers

	US	Russia	China	N Korea	India
Ballistic	Minuteman	Kh47 Kinzhal	DF-31		Agni-V
	Trident	R-29 series			
Cruise	AGM158 LRASM		CJ-10/20	Hawsong series	Nirbhay
	AGM 86 ALCM		YJ-12		
HGV	LRHW	Avangard (Nuclear capable)	DF-ZF boosted by DF-17	Similar to DF-ZF	HSTDV K-4 engine by DRDL
	IRCPS, AGM-183/ ARRW			Similar to SWERVE	ISRO ATV, ISRO Hava (TSTO)
HCM	HACM HAWC	Tsirkon	YJ-18/ Lingyun-1	-	Brahmos

The above mentioned missiles present a large spectrum of ballistic, cruise and hypersonic missile options to the major powers in the world. The complex technology of hypersonic weapons, especially HGVs has seen the game played mainly between the US and China. Contrary to the emblems of state capability, the participation in this development race by certain rouge states like North Korea, with certain visible actions,[12] has created a sense of urgency in the present threat dynamics. The recent employment of an aero ballistic weapon like the Kinzhal by Russia in the Ukraine War[13] has even made the

11. LRASM – Long Range Anti Ship Missile, ALCM – Air Launched Critical Missile, LRHW – Long Range Hypersonic Wpn, IRCPS – Intermediate Range Conventional Prompt Strikes, ARRW – Air Launched Rapid Response Weapon, HACM – Hypersonic Attack Cruise Missile, HAWC – Hypersonic Air Breathing Weapon Concept, HSTDV – Hypersonic Technology Demonstration Vehicle, SWERVE – Sandia Winged Energetic Reentry Vehicle Experiment, ATV – Advanced Technology Vehicle, TSTO – Two Stage to Orbit.
12. "North Korea Conducts a Successful Test of a Hypersonic Glide Vehicle (HGV) - Defense Update:," https://defense-update.com/20220112_korean-hgv.html. Accessed March 29, 2022.
13. "Russia Says It Has Used Its Kinzhal Hypersonic Aero-Ballistic Missiles In Ukraine", *The Aviationist*, https://theaviationist.com/2022/03/19/russia-kinzhal-ukraine/. Accessed on March 29, 2022.

The major advantage of HGVs over ballistics missiles, in terms of less reaction time, unpredictable path, combined with lower cost factors has placed this weapon at a higher level of threat in future warfare.

issue of air launched ballistics missiles remain relevant for future conflicts. The development of a bouquet of so-called 'invincible weapons' requires nations to adopt a holistic approach of 'threat-cum-capability development', before rushing to conclusive actions.

BOON AND BANE: HYPERSONIC GLIDE VEHICLES OVER BALLISTIC MISSILES

The recent employment of air launched ballistic missiles in the Ukraine War or the positive technological demonstration of HGVs by China[14] and North Korea have shattered the conception that these weapons are just theoretical and will never be actively employed. These weapons possess significant common advantages of large stand-off ranges, element of surprise, gradual improvement in weapon accuracy and degree of manoeuvrability capability in the terminal phase.

The major advantage of HGVs over ballistics missiles, in terms of less reaction time, unpredictable path, combined with lower cost factors has placed this weapon at a higher level of threat in future warfare. However, HGVs face a different set of challenge. The non-projectile path of HGVs results in the creation of ambiguity related to judgment about the intended target and the possibility of attracting an unintended and unmeasurable action from the adversary. These technological marvels have created a dilemma in the strategic stability between multiple powers of the world and, hence, attracted technological as well as diplomatic responses, changing the outlines of future wars.

IMPACT ON FUTURE WARFARE

The recent developments, which were earlier visualised only in science fiction, have brought the focus on two major faultlines around the world, which include:

14. "China's New Hypersonic Capability", Royal United Services Institute, https://rusi.org/explore-our-research/publications/commentary/chinas-new-hypersonic-capability. Accessed on March 29, 2022.

- *The existing surveillance and Anti-Missile Defence (AMD) systems are incapable of detecting the launch of HGVs*. The counter views against the existing AMD systems by a US study group[15] have brought forward the requirement to review the existing detection and interception capability to handle such future threats.
- *The belief of ballistic missiles/HGVs being multi-warhead capable, resulting in never being utilised by an adversary, has been proved to be wrong*.

The capability to achieve credible deterrence based on singular military capability is a distant dream. Akin to mosaic warfare, adversaries are reorienting their deterrence strategy by utilising new manoeuvre sets in future conflicts.

The ongoing Russia-Ukraine conflict has revealed various possibilities in future wars.

The emerging threats have brought forward certain aspects impacting the outlook of future warfare. Prior to preparation for handling a future threat, it is essential to measure the extent of the threat and sketch the outline for future solutions.

- **Expansion of Engagement Space:** The large stand-off capability of these weapons, with the capability to follow unpredictable and delayed detection trajectories, has significantly expanded the geo-engagement space.
- **Changed Orientation of Deterrence Strategy:** The capability to achieve credible deterrence based on singular military capability is a distant dream. Akin to mosaic warfare,[16] adversaries are reorienting their deterrence strategy by utilising new manoeuvre sets in future conflicts such as employment of multi-domain-based technological solutions in sync with diplomatic and economic strangulation.

15. "No US Missile Defense System Proven Capable Against 'Realistic' ICBM Threats", Study: Breaking Defense, https://breakingdefense.com/2022/02/no-us-missile-defense-system-proven- capable-against-realistic-icbm-threats-study/. Accessed on March 29, 2022.
16. "DARPA Tiles Together a Vision of Mosaic Warfare," https://www.darpa.mil/work- with-us/darpa-tiles-together-a-vision-of-mosiac-warfare. Accessed on March 29, 2022.

- **Proliferation of Niche Technology:** The open proliferation of niche technology to act as a balancer against a common adversary has taken a fast pace in the present scenario. The plans of China offering the DF-17 to Pakistan[17] and the stark similarity of the North Korean HGV with the Chinese HGV[18] are recent developments which also require to be appropriately factored in.

The threat sketch outlined above demands that nations prepare a strategically well thought out plan to handle all the challenges posed through the development/possible employment of HGVs/ballistic missiles by an adversary. The '*Strategy of Six Ds*'-based capability build-up needs to be adopted for providing possible solutions to handle these threats in the future. The details of these suggested strategies are as mentioned below:

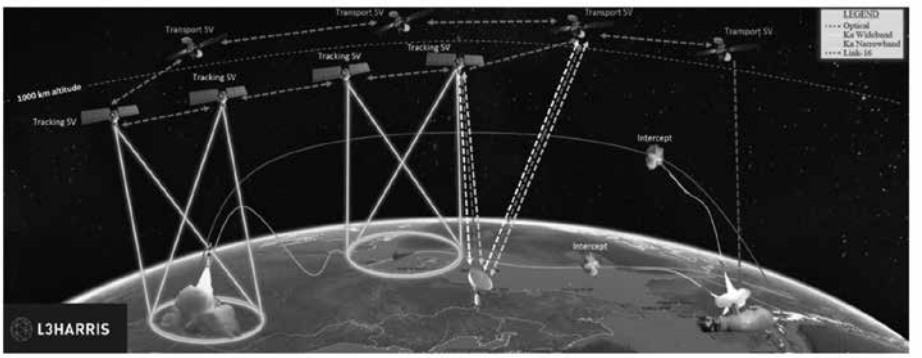
- **Detection Globally:** The positive engagement of these long-range weapons requires a global quick detection capability. This large detection demand can be achieved only through a network of space-based sensors, airborne Electronic Warfare (EW) assets and over the horizon radars. These sensors are required to be part of a single national networked architecture linking Low Earth Orbit (LEO) and Geosynchronous Earth Orbit (GEO) satellites with air and ground surveillance assets. This set will be able to timely detect ballistic missile launches and requires additions for HGV launch or mid-course detection.

  The challenge of the non-predictable path utilised by HGVs can be mitigated by equipping assets with high end Infra-Red (IR) sensors to track high thermal targets like HGVs.[19] The initiative of the US towards a

17. "China Could Offer DF-17 Hypersonic Missile to Pakistan Following Purchase of S-400 by India", Analysis Focus: Army Defence Military Industry Army, https://www.armyrecognition.com/analysis_focus_army_defence_military_industry_army/china_could_offer_df-17_hypersonic_missile_to_pakistan_following_purchase_of_s-400_by_india.html. Accessed on March 30, 2022.
18. "North Korea Claims Hypersonic Missile Test; Intel Community Unsure", *Air Force Magazine*, https://www.airforcemag.com/north-korea-claims-hypersonic-missile-test-intel-community-unsure/. Accessed on March 30, 2022.
19. Zachary W Hoeffner, "AFIT Scholar Theses and Dissertations Student Graduate Works a Computational Study: The Effect of Hypersonic Plasma Sheaths on Radar Cross Section for

National Defence Space Architecture (NDSA) supported through Space-Based Infra-Red (SBIR) sensors has enhanced the detection capability of this nation.[20] The global coverage with such sensors may be beyond the capability of nations, resulting in building strengths through inter-governmental agreements on space assisted information gathering and sharing.

Fig 3: US NDSA for Early Detection of Ballistic/HGV Missiles



- **Timely Decision:** The detection capability, once available, will demand timely decisions based on the extent of reaction time available, which will be severely restricted in the case of HGVs as compared to ballistic missiles. This extent of the threat would require pre-decided Rules of Engagement (RoE) and distributed command and control functioning under the support of Artificial Intelligence (AI) based auto decision aids and supervision of a defined command authority. The capability of HGVs to travel thousands of kilometres in minutes will require frequent reassessments for optimum application.
- **Defence Supported Through Offence:** The present anti-ballistic missile defence systems have been found to be incapable against HGVs and

Over the Horizon Radar", Recommended Citation, n.d.

20. "US Plans To Build 'Constellation Of Satellites' To Identify, Detect & Track Russian, Chinese Hypersonic Missiles," https://eurasiantimes.com/us-plans-to-build-constellation-of-satellites- russian-chinese-hypersonic-missiles/. Accessed on March 29, 2022.

even against a simultaneous multiple ICBM application. The assured level for destroying these weapons in flight faces major technological challenges. The futuristic technological solutions in terms of Directed Energy Weapons (DEWs) might provide interception and destruction capability in the future.[21] In the absence of such defence technology against weapons like HGVs, a credible and massive offensive response is expected to be the only solution. This will require the nations under threat to build adequate numbers of multi-domain launch capable offensive weapons to overwhelm an adversary utilising ballistic missiles or hypersonic weapons. The viability of such arms-based destabilisation, especially due to the vehicles being capable of carrying multiple warheads, will also require nations to reassess their nuclear doctrines. These solutions will require close linkages of diplomatic environment control to avoid entering into the whirlpool of an arms race and short thresholds of escalation.

- **Denial is the Optimum Solution:** The employment of long stand-off weapons, including hypersonic weapons below the nuclear threshold, has been amply seen during the Russia-Ukraine War. It has been seen that the optimum solution against such weapons is to ensure denial of the adversary's main objective: the achievement of large effects through precision long stand-off weapon-based engagements. This can be best achieved through transiting from a "concentrated to a dispersed operations"[22] capability. In addition, operational conduct, supported by a multitude of decoys (passive as well as active) with an aim to deceive and deny the adversary its battle objective will also prove to be an optimum action.
- **Demonstrated Development:** The threat scenario in today's world has opened the gates of a continuous "No War No Peace" situation. This

21. Henry Obering, "Directed Energy Weapons Are Real And Disruptive," *Prism* 8, no. 3, 2019, pp. 36–47, https://www.jstor.org/stable/10.2307/26864275.
22. "Russian General Staff Chief Valery Gerasimov's 2018 Presentation to the General Staff Academy: Thoughts on Future Military Conflict—March 2018," https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/Jan-Feb-2019/Gerasimov-Future/. Accessed on January 16, 2022.

situation demands indirect actions of demonstrating niche technology development with the aim of 'strategic signalling'. The recent response action of undertaking a test launch of the Agni-V in October 2021[23] post the Chinese HGV launch in August 2021[24] was a counter-action with far-reaching strategic signalling effects. This indirect action-reaction-based technological development and demonstration has become an intrinsic action plan in the entire scheme of national strategy and has put tremendous pressure on military practitioners and scientists to remain in sync with the threat matrix and evolve optimum solutions.

- **Diplomacy Supported Drivers:** The development of highly capable ballistic and hypersonic weapons has disturbed the existing deterrence equation. The creation of gaps in the deterrence balance requires diplomacy supported drivers towards technological development and, if required, even proliferation. The close and coordinated approach between diplomacy and military technological development and demonstration has proved to be the master stroke in today's world level games. The presence of a strong leadership with clear national aims and objectives has provided the diplomatic booster to the military forces for handling these new threats of future warfare. This diplomatic strength is to be utilised towards assisting in technological development and military capability enhancement.

INDIAN PREPARATION FOR FUTURE WARFARE

India is presently transiting through testing times with a variety of hurdles in its path to become an active player on the world stage. Pakistan's identity crisis combined with an independent as well as overtly supported Chinese arms race have created dual stress for India. The action-counter-action-based approach has seen an exponential acceleration in the domain of ballistic missiles, adding to the threat scenario for India. In order to handle

23. "Agni-V | Missile Threat," https://missilethreat.csis.org/missile/agni-5/. Accessed on March 29, 2022.
24. "China Tests New Space Capability with Hypersonic Missile", *Financial Times*, https://www.ft.com/content/ba0a3cde-719b-4040-93cb-a486e1f843fb. Accessed on March 29, 2022.

India's sensor set-up requires augmentation in the number of satellites with IR-based sensors for boost and mid-course detection. In addition, India needs to participate in a world-based air and space surveillance architecture to shorten the detection timelines.

these challenges, India's recent actions and the recommended additions to the suggested 'Strategy of Six Ds', are as mentioned in the subsequent paragraphs.

- **Detection Capability Enhancement:** The Indian Ballistic Missile Defence (BMD) programme, based on a dual layer of exo and endo atmospheric detection and destruction capability against threats up to ranges of 2,000 km has recently seen a significant push through the induction of the Agni-5 with the capability to tackle threats up to 5,000 km.[25] However, the system is incapable of handling ICBM-based saturation and the new threat of HGVs. The Indian space and BMD programmes require a dual approach of sensor augmentation through development as well as cooperation. India's sensor set-up requires augmentation in the number of satellites with IR-based sensors for boost and mid-course detection. In addition, India needs to participate in a world-based air and space surveillance architecture to shorten the detection timelines.
- **Decision Cycle Review:** India has recently inducted the S-400 system[26] and operationalised a nuclear missile tracking ship, the INS *Dhruv*.[27] The availability of such long-range detection capable systems requires India to review the decision support system to tackle the enhanced threats posed through hypersonic weapons. There is a necessity to utilise an algorithm-based automated decision support system with a distributed

25. Ashok Sharma, "India's Missile Defence Programme: Threat Perceptions and Technological Evolution," 2009, www.claws.in.
26. "India Gets Initial Deliveries of Russian S-400 Systems Despite Threat of US Sanctions", *India News - Times of India*, https://timesofindia.indiatimes.com/india/india-gets-initial-deliveries-of-russian-s-400-systems-despite-threat-of-us-sanctions/articleshow/87704342.cms. Accessed on March 29, 2022.
27. "INS *Dhruv*: Indian Navy to Launch 1st Nuclear Missile Tracking Ship Today. Check Details," https://www.livemint.com/news/india/ins-dhruv-indian-navy-to-launch-1st-nucleur-missile-tracking- ship-today-check-details-11631241686255.html. Accessed on March 29, 2022.

command and control set-up to tackle such time critical threats.

- **Destruction Balanced Through Offence:** The capability to mitigate the large threat spectrum from ballistic and hypersonic weapons in India is still at an early stage. This destruction imbalance requires India to prepare an arsenal of highly capable offensive weapons which are multi-domain launch and multi-trajectory capable so as to balance this equation. The recent actions of the BrahMos range extension[28] and further trials of the hypersonic technology demonstrator vehicle[29] can be augmented through quick induction of these enhanced range weapons in adequate numbers.

The threat mitigation of the People's Liberation Army Rocket Force (PLARF) demands that the Indian military forces disperse and sustain the conduct of operations.

- **Deception Means to Sustain Operations:** The threat mitigation of the People's Liberation Army Rocket Force (PLARF) demands that the Indian military forces disperse and sustain the conduct of operations. In addition, the capability of such weapons which are dependent on specific tech-imagery data can be severely degraded through the induction of deception methods like electromagnetic decoys and smoke screens.
- **Development Independence and Demonstration:** The world is witnessing an unstable multipolar world, and greater dependency on any nation might result in India encountering dilemma situations in future conflicts. The recent initiative of "*Aatmanirbhar Bharat*"[30] is a visionary approach and needs to be pushed and demonstrated to the world. This approach, especially in the fields of space-based/airborne sensors, long

28. "Extended Range BrahMos Flight-Tested", *The Hindu*, https://www.thehindu.com/news/national/extended-range-brahmos-flight-tested/article38297322.ece. Accessed on March 29, 2022.
29. "India Issues NOTAM to Test HSTDV in January as Govt Fast-Tracks India's Hypersonic Missile Program", *The Commune*, https://thecommunemag.com/india-issues-notam-to-test-hstdv-in-january-as-govt-fast-tracks-indias-hypersonic-missile-program/. Accessed on March 29, 2022.
30. "Aatmanirbharbharat," https://aatmanirbharbharat.mygov.in/. Accessed on March 29, 2022.

range radars, hypersonic vehicles, anti-satellite weapons, directed energy weapons and long stand-off weapons is recommended to be pursued.

- **Diplomacy, the Ultimate Solution:** The large capability gap, especially with China, under the hidden dark shadow of a collusive threat from Pakistan, requires India to augment the military capability with the master orchestration of diplomacy. The present strong Indian leadership permits India to outmanoeuvre its adversaries with an unpredictable and synchronised demonstration of national capability, in the region as well as the world.

CONCLUSION

The dynamism in the changes of warfare from numerically-based attrition warfare to precise application of force from unprecedented stand-off ranges has created significant challenges for military planners and national decision-makers. The unbeatable trophy presently achieved by hypersonic vehicles is required to be competed for, and if possible, snatched, through quick development of defensive technologies. In the interim, it is important that India, along with like-minded world players, dribbles the politico-military ball in an effective manner with an aim to achieve the goal of strategic stability in the world.