Significance of Hypersonic Vehicles

Dr Roshan Khanijo[@]

Abstract

The development of new technologies like Hypersonic Vehicles has led to a revolution in military affairs. Since speed and manoeuvrability are important parts of these weapons, any country having this technology has an added advantage. This technology creates uncertainty for the adversaries as it becomes increasingly difficult to track these weapons. Further, dual use nature of these weapons will make it difficult for the adversary to decipher whether the approaching weapon is a nuclear or a conventional one and hence the competition amongst the nations to develop this technology. Though the technology was broached by the Americans, the Russian and the Chinese have conducted more tests and the number of nations developing hypersonic technology has increased. This has also impacted arms control and disarmament initiatives. This article analyses these issues.

Introduction

New tools and processes of waging war, like information warfare (IW), network-centric warfare (NCW), integrated Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR), system of systems, all powered by information technology (IT), have led to the revolution in military affairs (RMA).[1] Further the integration of satellite and computer technology has greatly enhanced and facilitated command and control and reduced time and space dimension to an extent that it is the new real time information gathering, processing and dissemination[2] which has become extremely critical to any warfare. Post-Cold War, with the advent of atomic age the nature of conflict changed. Nuclear weapons had decreased the possibility of a full-fledged war, but due to the development of new technologies fierce

[@]**Dr Roshan Khanijo** is Assistant Director (Research), at USI, New Delhi.

Journal of the United Service Institution of India, Vol. CXLIX, No. 617, July-September 2019.

arms race emerged amongst the major powers. One such technology which has been developed is the hypersonic technology.

Nature of Hypersonic Glide Vehicles (HGVs)

Hypersonic vehicles generally refer to flight of vehicles experiencing a sustained long-range manoeuvrable flight in the atmosphere layer, or trans-atmosphere layer at a Mach number above 5.[3] The main challenge, therefore, is the manoeuvrability and the hypersonic speed with which these vehicles travel. There are broadly two categories of hypersonic weapons; the Hypersonic Glide Vehicle (HGV) which is launched from a rocket and the second is Hypersonic Cruise Missile (HCM) powered by "scramjets"' capable of Mach 5+ speeds. Further, HGVs are unpowered after separation, do not follow a ballistic flight path after the boost phase, and so they may have an enhanced ability to overcome missile defences due to both, their manoeuvrability as well as their depressed trajectories relative to standard ballistic missiles.[4] This potential could change the deterrence calculus for nuclear-armed states, increase ambiguity in terms of crisis thresholds, and dramatically escalate a crisis or conflict if used.[5] Since the nations, particularly Russia and China, are developing dual use warheads (nuclear and conventional), the ambiguity in terms of nature and the target of the approaching weapon creates confusion which is further precipitated by their hypersonic speeds which alarm the adversary due to short reaction time. These weapons are, therefore, escalatory in nature and will invariably lead to arms race. Though the research on hypersonic weapons had started in the 1990s, it will be in the next few years that these weapons will be operationalised. Three major powers, namely Russia, China and the US, have advanced HGV acquisition programme. Though the Americans were the first to conduct preliminary tests but the other two countries have now conducted more tests than the Americans. France and Australia are also researching on this technology. Thus, the challenges to disarmament and arms control are bound to increase in future.

Development of HGVs

Though US was a pioneer of this technology in the past, the progress was restrained due to paucity of funds. Nevertheless, there has been an enhanced impetus in developing these weapons now, due to considerable progress achieved by Russians and

Chinese. The US is developing hypersonic programme for all the three Services and some of them are, Navy's Intermediate Range Conventional Prompt Strike Weapon (IR CPS); Army's Land-Based Hypersonic Missile (also known as the Long Range Hypersonic Weapon); Air Force's Hypersonic Conventional Strike Weapon (HCSW, pronounced "hacksaw"); AGM-183A Air-launched Rapid Response Weapon (ARRW, pronounced "arrow"); Defence Advanced Research Projects Agency's (DARPA)—Tactical Boost Glide (TBG); …and DARPA's Hypersonic Air-breathing Weapon Concept (HAWC, pronounced "hawk").[6] Army is developing it with the aim to "provide the Army with a prototype strategic attack weapon system to defeat Anti-Access/Area Denial (A2/AD) capabilities, suppress adversary's Long Range Fires, and engage other high payoff/time sensitive targets".[7] However, the navy's environment is very complex hence the navy is developing an IR CPS and is expected to pair the common glide vehicle with a submarine-launched booster system.[8] Similarly, the air force's ARRW is expected to develop an air-launched HGV prototype capable of travelling at speeds up to Mach 20 at a range of approximately 575 miles.[9] ARRW completed a successful flight test in June 2019 and is expected to complete further flight tests in financial year 2022.[10] Thus, the US is trying to refocus on this technology.

Russia's main objective was to develop a weapon which could neutralise American Ballistic Missile Defence (BMD) systems. The Russians developed the Kinzhal air-launched hypersonic missile system. The range of the Kinzhal air-launched hypersonic missile will reach about 3,000 km aboard the new Tu-22M3 carrier bomber, compared to over 2,000 km on board the MiG-31K fighter jet.[11] Russia has also increased its defence allocations and according to Jane's CNBC reports, in 2018, the Kremlin set aside $ 43 billion for defence.[12] They now have the 'Avangard' as their HGV, which along with conventional warhead may carry nuclear warhead also. The Avangard is a strategic intercontinental ballistic missile (ICBM) system equipped with a hypersonic glide vehicle.[13] It's designed to sit atop an ICBM and, once launched, it uses aerodynamic forces to sail on top of the atmosphere.[14] According to the data of Russia's Strategic Missile Force, Avangard hypersonic missile systems will enter combat duty at the Dombarovsky missile division in the Orenburg Region …Russia's

Defence Ministry noted, overall, 31 silo-based launchers of the Yars and Avangard missile systems are expected to assume combat duty.[15] This Russian weapon has a two way advantage, firstly its manoeuvrability, which as stated by President Vladimir Putin that, "the weapon is capable of performing sharp manoeuvres on its way to targets making it absolutely invulnerable for any missile defence system".[16] Second is its versatility as this weapon can be fitted with either conventional or nuclear payloads.

Like Russia, Chinese objective to develop HGVs was to neutralise the American BMD systems. They have their DF-ZF (formerly known as WU-14) HGVs. The DF-ZF HGV can allegedly reach speeds between Mach 5 and Mach 10, or 6,173 kilometres (3,836 miles) per hour and 12,359 kilometres (7,680 miles) per hour.[17] In 2017, China conducted two tests of a new missile known as the DF-17, the first test took place on November 1 and the second test on November 15.[18] Further, China also successfully tested Starry Sky-2 (or Xing Kong-2), a nuclear-capable hypersonic vehicle prototype, in August 2018.[19] The Starry Sky-2, which is an experimental design known as a wave rider – for its ability to ride on the shock waves it generates, completed its first test flight… and during independent flight it conducted extreme turning manoeuvres, maintained velocities above Mach 5.5 for more than 400 seconds, and achieved a top speed of Mach 6, or 7,344km/h (4,563mph).[20] This 'waverider' technology enables the aircraft to achieve greater manoeuvrability, which would invariably make its early detection difficult for the adversary. The cause of concern is also that it has the ability to carry nuclear warheads. Further, China has increased its defence spending especially in building advance versions of missiles, aircraft carriers, frigates, stealth warships etc. China's military spending is forecast to reach $ 203.3 billion, up nearly 6 per cent from $ 192.5 billion.[21]

India has also been researching on this technology and in 2008, the then DRDO Chief, VK Saraswat, had stated that through the Hypersonic Technology Demonstrator Vehicle (HSTDV) project, "we are developing a hypersonic vehicle that will be powered by a scram-jet engine, this is dual-use technology, which, when developed, will have multiple civilian applications. It can be used for launching satellites at low cost. It will also be available for long-range cruise missiles of the future".[22] India on her part has also conducted her first maiden test of an indigenously developed

HSTDV on 12 June 2019.[23] Though some technologies were validated through this test but for others, more tests are required.

Significance of Hypersonic Technologies

This technology is considered to be a game changer as far as military strategy is concerned. Any country having this technology has an added advantage, as it creates uncertainty for its adversaries on number of counts. The weapons' manoeuvrability allows them to travel on unpredictable trajectories, making it difficult to track and destroy them before they successfully penetrate advanced air and ballistic missile defences.[24] Lower signatures, and an ability to fly at lower altitudes, also compound the challenge of finding, targeting, and intercepting hypersonic vehicles for current missile defence systems like the Ground-Based Interceptor (GBI), Terminal High Altitude Area Defence (THAAD), and Patriot.[25] Since these weapons travel with great speed, the reaction time for the adversaries is greatly reduced and this is more pronounced for neighbours where the geographical distances are less. Further, the variation which this class of weapon provides makes it difficult for the adversary to decipher whether the approaching weapon is a nuclear or a conventional weapon and as a result a conventional strike may be conceived as nuclear strike. This may lead to nations' rethink of their strategic postures and may think of using their nuclear weapons against an attack with these weapons, thus placing their weapons on high alert. This technology is thus, escalatory in nature and presents a challenge to the nations who are developing it, as also to Arms Control and Disarmament regimes who are already under tremendous constraints due to abrogation of Intermediate-Range Nuclear Forces (INF) Treaty.

Further, US is already trying to find the countermeasure.The 2019 US Missile Defence Review stated that the US Department of Defence has a HGV defence programme which has "demonstrated a limited capability to defend against HGVs in the terminal phase, and is pursuing new capability for early warning and tracking of HGVs".[26] Some analysts have suggested that space-based sensor layers—integrated with tracking and fire-control systems to direct high-performance interceptors or directed energy weapons—could theoretically present viable options for defending against hypersonic weapons in the future.[27] Such sensors take advantage of the large area viewable from space for improved

tracking and potentially targeting of advanced threats, including HGVs and HCMs.[28] In future, 'space' would become a significant frontier and competition would be to develop technologies to control this domain. Thus, this will further exacerbate arms race as technology driven innovations give impetus to nations to compete in order to maintain the strategic balance. This trend of advancements in niche technologies has put disarmament and arms control at a back stage. There are no signs visible that in near future any substantial efforts would be made to control the technological advancements of major powers.

Conclusion

Nuclear weapon states have aimed to maintain deterrence by developing their triads but now with the advent of hypersonic technology, a new layer has been added to the game. With the weaponisation of hypersonic technology, concept of nuclear deterrence will also be challenged. The arms race which will follow will add new complexities where apart from nuclear weapon states, other nations will be forced to develop this technology to prevent coercion, as also, space would become the next frontier of competition and dominance.

Endnotes

[1] Sharjeel Rizwan, 'Revolution in Military Affairs (RMA)', at http://www.defencejournal.com/2000/sept/military.htm

[2] Ibid

[3] Zhiqiang Chen and Yonghui Zhao, 'Aerothermoelastic Analysis of a Hypersonic Vehicle Based on Thermal Modal Reconstruction', International Journal of Aerospace Engineering Volume 2019, Article ID 8384639, at https://www.hindawi.com/journals/ijae/2019/8384639/

[4] 'Hypersonic Weapon: A Challenge and Opportunity for strategic Arms Control', United Nations Office for Disarmament Affairs United Nations Institute for Disarmament Research, 2019

[5] Ibid

[6] Hypersonic Weapons: Background and Issues for Congress, Congressional Research Service, July 11 2019, at https://fas.org/sgp/crs/weapons/R45811.pdf

[7] Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Army Justification Book of Research, Development, Test and Evaluation, Volume II, Budget Activity 4, pp. 579-584, https://www.asafm.army.mil/documents/BudgetMaterial/fy2020/rdte_ba4.pdf; and Sydney J. Freedberg Jr., "Army Sets 2023 Hypersonic Flight Test; Strategic Cannon Advances," Breaking

Defense, March 19, 2019, https://breakingdefense.com/2019/03/army-sets-2023-hypersonic-flight-test-strategic-cannon-advances/.

[8] Steve Trimble and Guy Norris, "Sandia's Swerve Could Lead to First-gen Hypersonic Production Line," Aviation Week, October 11, 2018, http://aviationweek.com/air-dominance/sandia-s-swerve-could-lead-first-gen-hypersonic-production-line; and Sydney J. Freedberg, Jr., "Army Warhead Is Key To Joint Hypersonics," Breaking Defense, August 22, 2018, https://breakingdefense.com/2018/08/army-warhead-is-key-to-joint-hypersonics/.

[9] Hypersonic Weapons: Background and Issues for Congress, Congressional Research Service, July 11 2019, at https://fas.org/sgp/crs/weapons/R45811.pdf

[10] Ibid

[11] Russian strategic bomber to extend Kinzhal hypersonic missile's range' TASS Russian Military Agency ,July 18 2017, at http://tass.com/defense/1013794

[12] 'Introducing 'Avangard' and 'Sarmat': Putin shows off new hypersonic, nuclear missiles', The National Post, March 01, 2018 at https://nationalpost.com/news/world/introducing-the-avangard-hypersonic-missile-a-look-inside-putins-new-high-tech-arsenal

[13] TASS Russian New Agency 02 July 2019, at https://tass.com/defense/1066695

[14] Amanda Macias 'US intelligence reports: Russia's new hypersonic weapon will likely be ready for war by 2020', https://www.cnbc.com/2018/05/15/russia-hypersonic-weapon-likely-ready-for-war-by-2020-us-intel.html

[15] TASS Russian New Agency 02 July 2019, at https://tass.com/defense/1066695

[16] Avangard (Hypersonic Glide Vehicle), Missile Defence Advocacy Alliance (MDAA),AT https://missiledefenseadvocacy.org/missile-threat-and-proliferation/missile-proliferation/russia/avangard-hypersonic-glide-vehicle/#_edn5

[17] Franz-Stefan Gady, "China Tests New Weapon Capable of Breaching US Missile Defense Systems",28 April 2016, at https://thediplomat.com/2016/04/china-tests-new-weapon-capable-of-breaching-u-s-missile-defense-systems/

[18] Ankit Panda, "Introducing the DF-17: China's Newly Tested Ballistic Missile Armed With a Hypersonic Glide Vehicle", The Diplomat, 28 December 2017, at **https://thediplomat.com/2017/12/introducing-the-df-17-chinas-newly-tested-ballistic-missile-armed-with-a-hypersonic-glide-vehicle/**

[19] Jessie Yeung, "China claims to have successfully tested its first hypersonic aircraft. CNN, August 7, 2018, https://www.cnn.com/2018/08/07/china/china-hypersonic-aircraft-intl/index.html. See also U.S.-China Economic and Security Review Commission 2018 Annual Report, p. 220, https://www.uscc.gov/sites/default/files/annual_reports/2018%20Annual%20Report%20to%20Congress.pdf.

[20] Liu Zhen , "China's hypersonic aircraft, Starry Sky-2, could be used to carry nuclear missiles at six times the speed of sound", South China Morning Post, 06 August 2018, at https://www.scmp.com/news/china/diplomacy-defence/article/2158524/chinas-hypersonic-aircraft-starry-sky-2-could-be-used

[21] Craig Caffrey, principal analyst at IHS Jane's, as quoted in 'Global defense spending to reach levels not seen since end of Cold War', by Jeff Daniels, CNBC Report, December 18,2017 at https://www.cnbc.com/2017/12/18/ihs-janes-global-defense-spending-to-see-best-growth-rate-in-decade.html

[22] Dinakar Peri, "DRDO conducts maiden test of hypersonic technology demonstrator", The Hindu, 13 June 2019, at https://www.thehindu.com/news/national/drdo-conducts-maiden-test-of-hypersonic-technology-demonstrator/article27890922.ece

[23] Ibid

[24] Geoff Brumfiel, "Nations Rush Ahead with Hypersonic Weapons Amid Arms Race Fear," National Public Radio, October 23, 2018: https://www.npr.org/2018/10/23/659602274/ amid-arms-race-fears-the-u-s-russia-and-china-are-racingahead-with-a-new-missil.

[25] Sydney J. Freeberg Jr., "DoD Boosts Hypersonics 136% in 2019: DARPA," Breaking Defense, March 1, 2018: https:// breakingdefense.com/2018/03/dod-boosts-hypersonics-136- in-2019-darpa/.

[26] US Department of Defense, "Missile Defense Review 2019", p. 58.

[27] Hypersonic Weapons: Background and Issues for Congress, Congressional Research Service, July 11 2019, at https://fas.org/sgp/crs/weapons/R45811.pdf

[28] Department of Defense, 2019 Missile Defense Review, p. XVI, https://media.defense.gov/2019/Jan/17/2002080666/-1/-1/1/2019-MISSILE-DEFENSE-REVIEW.PDF.