Hypersonic Weapons and Strategic Stability: How Grave is The Challenge?

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Abstract

Hypersonic weapons are becoming a reality with the deployment of Avangard glide vehicle by Russia and the successful testing of such weapons by China and the US. Built to overcome ballistic missile defenses, these weapons are often touted as unstoppable and a possible game-changer. Unlike traditional missiles, hypersonic glide vehicles glide towards their targets giving the defender no time to respond and intercept them. These weapons impact strategic stability by compressing the decision-making time, increasing counterforce temptations due to their precision targeting, and by causing a new arms race. The ability to carry both conventional and nuclear warheads off these weapon can also lead to miscalculation and inadvertent escalation.

With weakening arms control and trust deficit at the global level, the global strategic stability would be under stress with the induction of these weapons in nuclear-weapon states' inventories until some confidence-building measures are adopted. They will continue to challenge the strategic stability even after new systems are developed to counter them.

Keywords

Strategic Stability, Avangard, First-Strike, Arms Race, Russia, Defense Advanced Research Projects Agency (DARPA) Missile Defenses, Cruise Missiles.

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Introduction

With the rapidly changing global geostrategic environment, strategic stability is at the risk of becoming unstable. Nationalistic trends globally and great power competition in a multipolar world have become more visible since 2018. The US Nuclear Posture Review 2018, the US withdrawal from Joint Comprehensive Cooperation Agreement (JCPOA), and the US exit from the Intermediate-range Nuclear Forces Treaty (INF) among other developments have had a disconcerting effect on the global strategic environment. Coupled with these new developments, the military use of new technologies can also have an adverse effect on strategic stability. New hypersonic weapons are currently under-development in the US, Russia, and China. Russian President Vladimir Putin in his State of Nation Address in March 2018 unveiled that Russia is developing new types of strategic weapons, including Avangard hypersonic glide vehicle and Anti-ship hypersonic missile, Zircon. The US and China are also developing similar hypersonic weapons. The US and China have tested Common-Hypersonic Glide Body (C-HGB), and DF-17 respectively. A key feature of these weapon systems is their fast speed and maneuverability which enables them to evade the enemy air defenses.

Russian President blamed the US for reviving the strategic arms race when former U.S. President Bush decided to opt out of the 1972 Anti-Ballistic Missile Treaty in 2002. While the Americans blame Russian actions for a possible arms race including the annexation of Crimea and involvement in Ukraine; however, with the addition of China as another power, the strategic relations of the three most powerful states in the world have become even more challenging.

In this environment, the introduction of new hypersonic weapons acts as a primer for increased competition between the super-powers and has great potential to hamper strategic stability between them. This paper will discuss the current state and future direction of hypersonic weapons and their impact on global strategic stability.

The Concept of Hypersonic Weapons

Missile defenses are deployed to prevent enemy missiles from reaching their targets. However, with missile defense in place, the offensive missiles would need to be enhanced in terms of power as well as numbers so as to be able to penetrate the defense systems. This is a classical offense-defense struggle. Although the credibility and capabilities of current missile defenses are questionable, countries are developing new technologies that can overcome even these limited defenses. Current missile defenses can intercept missiles traveling up to a certain range at a certain speed due to technological barriers. There are various political, economic, and technological factors behind the development of new technologies. But the primary argument for developing these technologies remains the missile defenses.

Three characteristics of a weapon are important to defeat defenses: its speed, maneuverability, and altitude. Available missiles do not offer all three characteristics in one platform. Ballistic missiles lack maneuverability and current cruise missiles lack speed.[1] Some degree of maneuverability in the Maneuverable Re-entry Vehicles (MaRVs) has been achieved, however, they still follow a ballistic trajectory that is in contrast to what glide vehicles do.[2] The solution to overcoming defenses is aimed at finding the integration of speed and maneuverability in one system. Hypersonic missiles are designed to travel at speeds greater than Mach 5 with maneuverability at low altitude. A hypersonic weapon system can, for example, cover a distance of 1,000 km in about 10 minutes at Mach 5. To put speed and range into perspective, the US subsonic Tomahawk cruise missile can travel 1000 km at Mach 0.75 in about 67 minutes.[3] New hypersonic weapons are technologically different than the existing ballistic and cruise missiles. These systems are of two types, Hypersonic Glide Vehicles (HGVs) and Hypersonic Cruise Missiles (HCMs).

Hypersonic Glide Vehicles are mounted on rockets and launched into the upper atmosphere usually at the altitude above 50 km. Onward,

the glide vehicles travel to their targets at hypersonic speeds with greater maneuverability in the atmosphere. The glider does not follow a ballistic trajectory due to its non-dependence on gravitational forces. The glide vehicle itself is unpowered and it uses aero-dynamics to maneuver. In contrast to the ballistic missile's re-entry vehicles, glide vehicles have longer range, can transport a heavier payload, can maneuver during the midcourse phase, and fly at lower altitudes.[4]

The other type is hypersonic cruise missiles. They are powered by a new type of engine, Supersonic Combustion Ramjet (SCRAMJET). It uses Oxygen from the atmosphere rather than the onboard tank. The need to get Oxygen from the environment also makes hypersonic cruise missiles fly lower in the atmosphere. This makes the craft smaller, lighter, and faster. A scramjet can travel up to a speed of Mach 15.[5]

There are however several technological challenges faced by the hypersonic vehicles entering the atmosphere, including the effects of the thermal and aerodynamic force. These challenges need to be overcome to maintain the structural integrity of a hypersonic vehicle. Heating increases with the increase in speed and atmospheric density. This requires unique materials that can withstand higher temperatures. These vehicles must also stay stable against the high lift and drag forces. Moreover, the issue of navigation requires a technical solution to make communication possible through the plasma which develops around the vehicle at hypersonic speed.

Current Developments in Hypersonic Domain

Hypersonic technologies, especially for military purposes, are currently under-development in the big three, i.e. the U.S., Russia, and China. France and India are two other countries that have made considerable progress in hypersonic technology. India in collaboration with Russia is working to develop these technologies.[6]

Other countries that are committed to developing hypersonic technology include Australia, Japan, and the European Union.

Russia is the first country to have operationally deployed hypersonic weapons in December 2019. Russian President Putin in one of his prominent speeches unveiled the new strategic weapons –being developed in Russia to counter the US missile defenses– referring to a direct connection between the missile defenses and new missiles. Among the new weapons is the hypersonic Avangard glide vehicle with the speed of Mach 20, twenty times faster than the speed of sound. It was successfully tested on December 26, 2018 and entered service in 2019. Its speed can easily defeat current and prospective missile defenses.

The other hypersonic weapon under development in Russia is an anti-ship missile called 3M22 Zircon with the targeting range of 400 km at the speed greater than Mach 6.[7] It can be launched from both the surface ships and submarines and carry both conventional and atomic payloads. The Zircon can target large ships, cruisers, and aircraft carriers. Zircon can also strike ground targets.[8] The missile extends the engagement range of Russian ships and puts Russian sea-denial capability in a more competitive position. It started the trial on ships and submarines in 2019.[9] The Admiral Nakhimov and the Pyotr Veliky nuclear-powered missile cruisers will be the first to receive the new weapons onboard.[10]

The US is engaged in extensive efforts to develop hypersonic technologies. The deployment of Russian Avangard has put a sense of urgency in the US' efforts to develop hypersonic weapons. Pentagon has tested Common-Hypersonic Glide Body and the US Air Force is developing Air-Launched Rapid Response Weapon (ARRW). The Army is working on Long-Range Hypersonic Weapon (LRHW), and the Navy on Conventional Prompt Strike. The Defense Advanced Research Projects Agency (DARPA) is developing four different hypersonic weapons like Tactical Boost Glide (TBG); DARPA—Advanced Full-

Range Engine (AFRE); DARPA—Operational Fires (OpFires); and DARPA—Hypersonic Air-breathing Weapon Concept (HAWC).[11]

China is developing a hypersonic glide vehicle that it has been testing since 2014. The Western sources have maintained that China has conducted several tests of WU-14/DF-17 HGV. It was displayed during PLA's military parade in Beijing on October 01, 2019.[12] Another glide body, Starry Sky 2 is developed by the China Academy of Aerospace Aerodynamics in Beijing. It reached the speed of Mach 6.[13]

India is developing a hypersonic version of the Brahmos supersonic cruise missile, in collaboration with Russia, to reach the Mach 5 threshold.[14] Brahmos supersonic missile can carry different types of warheads including a nuclear warhead at the range of 290 km and can be launched from multiple platforms including ships, submarines, land, and aircraft.[15] After the Indian membership of the Missile Technology Control Regime (MTCR), it is increasing the range of the missile.[16] Russian hypersonic missile Zircon is said to be identical to the Brahmos II.[17] Other than the Brahmos II, India is engaged in the R&D of indigenous Hypersonic Technology Demonstrator Vehicle (HSTDV) to produce a scramjet engine capable of reaching Mach 7 speed. The first test of HSTDV was carried out on June 12, 2019.[18] The test reportedly failed to achieve desired results further delaying the development goals.[19]

France is also developing hypersonic weapons. France's national aerospace research center, ONERA is exploring engine technologies to reach Mach 8 speed to develop an air-to-surface missile, known as ASN4G.[20] The French Defense Minister, Florence Parly announced that since they had the know-how of hypersonic technology they could no longer afford to wait. France wants to test its Project V-MaX (Experimental Maneuvering Vehicle) by 2021. It aims to create a hypersonic glider with a speed of more than 3,700 miles per hour, or Mach 5.[21] France could also be the first European nation to develop such weapons since no information is available about other European

nations' programs. The development of hypersonic vehicles may also be linked to the French prestige factor in the 21st Century more than security reasons.

Impact on Global Strategic Stability

Strategic stability is defined as a balance of capability and intent between the competitors.[22] Technologies such as hypersonic weapons enhance the offensive capabilities of a country and thus influence the calculations of both the aggressor and the threatened. According to the Offense-Defense Theory when the offensive capability is strong there is increased likelihood of international conflict and war.[23] Therefore, hypersonic weapons' development along with their defenses in the long run risks crisis stability, increases chances of misconception, miscommunication, inadvertent escalation, and arms race among the key powers.

Restoring or Eroding Strategic Stability?

Russian President Vladimir Putin claimed that the Russian hypersonic weapons have restored the strategic stability between the US and Russia which was eroded after the US withdrawal from the Anti-Ballistic Missile Treaty in 2002. The question however remains how would this impact the strategic stability and what would happen when the US also deploys its hypersonic missiles?

One argument can be that since the US, Russia, and China would eventually all possess hypersonic weapons, hence there would be a balance among them. This would discourage first strike temptations by any side which intrinsically would improve strategic stability.

But what happens to the US ballistic missile defenses then? Does it mean that Russia is not going to use its traditional ballistic missiles due to fear of the US missile defenses and would largely rely on hypersonic weapons? This may not be the case. As of now, China does not have a strategic ballistic missile defense system, it is only engaged in the Research & Development (R&D) of it and there is no official

word on their eventual development and deployment.[24] Therefore, to offset the US missile defense advantage, China is developing hypersonic weapons to neutralize US missile defense advantage. With the presence of missile defenses in one of the countries, deployment of hypersonic weapons by others may essentially not bring stability among them. Theoretically, the US could consider using its hypersonic weapons to preempt Russian and Chinese hypersonic weapons and let its missile defenses deal with their traditional ballistic missiles. The US and Russia are already known to have been exploring anti-hypersonic options with Russia touting S-500 as capable of intercepting a hypersonic weapon.[25] Although, it will be impossible to take out all the HGVs in a first strike and intercept all traditional ballistic missiles by defenses. Similarly, Russia and China could also contemplate using their hypersonic weapons to neutralize US missile defenses in a crisis situation. In reality, the US may not be able to destroy all the Russian and Chinese hypersonic weapons and its missile defenses may not be able to intercept all the ballistic missiles. Therefore, the development of missile defenses remains a point of dispute in strategic stability debate[26] that has led to the development of hypersonic weapons.

Targeting Implications

The RAND Cooperation report has identified some of the strategic implications of hypersonic weapons including the constraints on timelines and targets.[27] Hypersonic weapons can carry both nuclear and conventional warheads as already mentioned. However, both types of warheads will have strategic implications. Since hypersonic weapons can strike farther and harder than other non-nuclear weapons, James Acton believes that non-nuclear hypersonic weapons will give Russia and China the ability to strike a target in Europe and the US, which in the past, could only have been targeted with nuclear weapons carried on ballistic missiles.[28]

Warhead ambiguity will be another challenge. When a hypersonic missile is fired, the adversary would not be sure of whether it is carrying a nuclear or conventional warhead. It is the case with most of the missiles but in hypersonic missiles case, short reaction time will complicate the warhead ambiguity. Since both the US and Russia keep their nuclear weapons on hair-trigger alert, there can be a miscalculation and resultant nuclear exchange. Acton also maintains that, unlike Russia and China, the US is investing in greater accuracy of hypersonic weapons with the ability to hit targets with pinpoint accuracy. The pinpoint accuracy adds value to the counter-force strike capability.

Russian Avangard has been confirmed ability to carry nuclear warheads and can carry a nuclear warhead of two megatons.[29] As of now, the United States is building hypersonic missiles as part of its Conventional Prompt Global Strike. It may also add the nuclear dimension to the hypersonic missiles because hypersonic weapons provide a safer and reliable means to deliver nuclear warheads. China may also be poised to assign a nuclear role to them. Other than the conventional and nuclear warheads the kinetic kill energy (hit to kill) of HGVs is greater than the traditional ballistic missiles.

At the strategic level, hypersonic weapons would be deployed against high-value targets like command and control centers, nuclear storage facilities, ICBM silos, large carrier strike groups among other targets.[30] Unlike in the past, when ICBMs silos could only be targeted with nuclear weapons, conventional warheads can now destroy hard targets like the ICBMs silos. Thus, making hypersonic weapons devastating even in the absence of their nuclear dimension.[31] Maneuverability also gives HGVs and HCMs the ability to strike moving targets, unlike a normal ICBM re-entry vehicle which has limited capability to destroy moving targets. The transport erector launchers (TELs) are considered safe from a legacy ballistic missile strike but they will be vulnerable to HGVs and HCMs with the help of advanced Intelligence, Surveillance, and Reconnaissance (ISR)

capabilities. However, this will depend on the flight control, guidance, and maneuverability of HGVs and HCMs. The same is the case with the naval assets, they can be targeted with the HCMs more efficiently.

At the tactical level, Michael Griffin, a former NASA administrator believes that since they are very quick, high speed, highly maneuverable, difficult to find and track and kill, hypersonic weapons could be particularly effective as tactical weapons against the US naval assets.[32] The US naval and other military assets in Asia-Pacific will be the target of Chinese hypersonic weapons. In a conflict with the US, China will strike these US targets at sea and land in Asia. According to Roger Zakheim, a member of the US National Defense Strategy Commission, these weapons hold aircraft carriers, ships, and bases at greater risk and China can keep the US away from the South China Sea.[33] Vsevolov Khmyrov, a retired Russian rear admiral claimed that if the US decides to use its INF Treaty banned weapons against it, Russia could target the US command centers within five minutes using Zircon missile from sea-based platforms.[34] Targeting the US command and control centers in mainland US with Zircon missile would mean Russian submarines and warships would have to come near the US shores.

In the South Asian context, the Indian Brahmos supersonic cruise missile is designated against naval assets along with the land targets. Its successor Brahmos II will also have the same targeting options. Japan is also developing both hypersonic cruise missile and glide vehicle. One of the weapon's warhead is designed to attack warships deployed in the sea around it. These are likely to enhance its capability to protect its islands in the East China Sea.[35]

A New Arms Race

Hypersonic weapons have already set in an arms race among the major powers. The Trump administration which has already clarified its position vis-à-vis Russia and China in its key policy documents like

the National Defense Strategy, the Nuclear Posture Review, and the Missile Defense Review (MDR). These important documents have termed Russia and China as competitive great powers and seek a greater role for nuclear weapons in US security. The MDR 2019 has placed more focus on missile defenses.[36] This kind of posturing indicates the trends of great power rivalry in the future.

This environment of great power competition provides fertile grounds for an arms race. China and Russia are primarily motivated to develop hypersonic weapons by the development of the US missile defenses and first strike capabilities as claimed by Russian and Chinese officials. Other then the missile defenses, the major reason for Chinese hypersonic weapons is the development of the US Prompt Global Strike system. The system is designed to attack targets anywhere in the world using conventional weapons in as little as an hour.[37] China, like Russia, believes that the US can preempt and decapitate its nuclear forces and limit its ability to retaliate against the US.[38] The US in turn believes Russia and China are challenging its global superiority, cites Russian and Chinese military developments as threatening to its sole authority. It believes it stands to lose if it doesn't counter Chinese and Russian developments for two reasons. First, it has been left behind in the hypersonic race and secondly, it can fear a first strike from Russia after the deployment of Avangard along with its other new strategic weapons. The US has adopted a two-pronged strategy; first to neutralize the threat posed by Russian weapons by building new and improving the existing defenses and developing similar weapons that can hit Russian targets at the same level of risk. But due to credibility and capability issues even against traditional ballistic missiles, missile defenses are the secondary part of its strategy.[39] Demonstration of its hypersonic technologies is the primary response to the Russian and Chinese hypersonic weapons.

The US has already demonstrated hypersonic technology and has a strong R&D base for further development of these systems. This will lead to a new phase of arms competition between great powers. US

Under Secretary of Defense for Research and Engineering, Michael Griffin stated in an interview in July 2018, "You're going to see our testing pace stepping up, and you're going to see capability delivery from the early '20s right through the decade."[40] DARPA has also started to develop and demonstrate defensive technologies against hypersonic glide vehicles in its "glide breaker" project.[41] As mentioned, France, India, and Japan are also part of the hypersonic weapons development race.

The US geopolitical rivalry with Russia and China along with the weakening arms control arrangements and a decline in trust have provided the necessary ingredients for arms race instability. From the Russian perspective, it can be said that the US missile defenses caused the development of the Russian offensive forces intensifying the offense-defense cycle.

Unless credible defenses are put in place against them, the use of hypersonic missiles will be deterred by developing a similar weapon by the adversaries. This will add to the military budgets and needs for a credible arsenal. Whether a country is building hypersonic defenses in response to hypersonic threats or building a similar offensive power, a new arms race is already underway. Russian President Putin has stated that Russia will be developing defenses against such weapons before other countries develop them.[42] The S-500 air-defense system is being touted as one such capability.

Aggravating the Fear of Preemption

The Russian Avangard weapon system is deployed on UR-100NUTTkH (NATO reporting name: SS-19 Stiletto) intercontinental-range ballistic missile (ICBM). It will be launched from missile silos at the Dombarovsky missile site. Initially, two missiles will be deployed each with a single glide vehicle and this number will be increased to six.[43] High speed and maneuverability of hypersonic weapons require lesser time to reach the target. The opponent is left with less time to

decide and less time to respond. Since Avangard silos are fixed targets they are easy to destroy in a preemptive strike. This can give the adversary the temptation to strike first and disarm them. The new US MDR has indicated preemptive strikes by integrating passive and active defenses. The MDR states, "the United States will seek to use the same sensor network to both intercept adversary missiles after their launch, and, if necessary, strike adversary missiles prior to launch."[44] Because the response time to an incoming hypersonic missile is very short and their target remains unknown closer to the impact, this will impose time constraints on the party under attack. In an extreme situation, if the hypersonic gliders and cruise missile can be taken in the first strike then the opponent may think that the conventional ICBMs would be taken down by the BMDs. Here, the BMDs play an auxiliary role in a first strike. So, the best bet for the US would be to take out Avangard before it is launched. This brings back the use it or lose it dilemma of Cold War Era. Russian decision makers would think of using Avangard before losing it after the detection of incoming missiles towards it, resulting in crisis instability. The newly released Russian Presidential Executive Order on Principles of State Policy of the Russian Federation on Nuclear Deterrence mentions the launch of nuclear weapons on the detection of enemy's launch of ballistic missiles against Russian or its allies territory.[45]

The other important feature of the US MDR is the focus on intercepting missiles in their boost phase. Avangard glider is launched from traditional ICBM and follows the ballistic trajectory until the glider separation. After separation, the glider can maneuver to avoid interception making boost phase the most feasible option to destroy. For this purpose, the US MDR vows to enhance space-based sensors.[46] It also states that the US F-35 Lighting II aircraft can detect missile launches and can be equipped with interceptors to destroy them in the boost phase. Due to this, the F-35 can act as a mobile tracking system and in the future as a possible ballistic missile interceptor.[47]

Chinese believe that the US conventional prompt global strike capability can disarm its nuclear capability, to ensure the survival of its nuclear forces it will have to take security measures as China adheres to the No-First-Use policy. China will have to secure its nuclear forces to absorb the first attack and retain the ability to launch a retaliatory strike.[48] This will require not only more advanced ISR capabilities, but it may also keep its forces on some level of alert.

South Asia and Hypersonic Weapons

India is working to beef up its missile defenses, counterforce, and ISR capabilities which have tilted the strategic balance in its favor against Pakistan.[49] Its indigenous ballistic missile defense system consists of a two-tier system – the Prithvi Air Defence (PAD) for high altitude (exo-atmospheric interception) and Advanced Air Defence (AAD) for low altitude or endo-atmospheric interception. It is developing accurate delivery vehicles in large numbers such as Brahmos and Nirbhay cruise missiles and MIRVs along with high-resolution imaging satellites such as Cartosat-2 and RISAT-1 and RISAT-2.[50] The new US MDR has also called for closer cooperation with India to build missile defenses.[51] In this regard, the U.S. Department of State has approved the sale of an integrated air defense weapon system (IADWS) to India for $1.867 billion.[52] The Indian No-First-Use policy has also come under serious question in recent months.[53] It is now believed in strategic circles that India is seriously reviewing its No First Use policy. Christopher Clary and Vipin Narang write that India may be developing both counterforce capabilities and strategies to target military bases and concentrated armored formations.[54] It has also demonstrated its anti-satellite technology on March 27, 2019, by destroying one of its satellites.[55] Because of the flexibility of its nuclear doctrine,[56] the preemptive strike against Pakistani strategic nuclear assets can't be ruled out. As Clary and Narang write the elimination of adversary's strategic nuclear weapons will be tempting for India.[57] The combination of these developments makes South Asia

among the least stable regions in the world. The crisis-prone nature of the region was demonstrated during the Balakot-Rajouri crisis between India and Pakistan.[58]

The development of hypersonic weapons by India will have more serious implications for strategic stability in South Asia.[59] India will have acquired an added capability to conduct a first strike against Pakistan and with its missile defenses the ability to shoot down the remaining missiles launched by Pakistan in a retaliatory strike. These technological developments by India have put Pakistan in a disadvantageous position vis a vis its adversary. This gap will put pressure on Pakistan to bridge the gap and acquire similar technologies to ensure its security. Acquiring similar technologies, however, will be a long term option for Pakistan. For time being, Pakistan can add more ambiguity in its nuclear use policy and make operational changes such as enhancing the readiness of its nuclear weapons to survive a preemptive strike.[60] Fearing the preemptive strike from India, as an extreme measure, Pakistan may decide to launch its strategic weapons before they are decapitated by an anticipated Indian first strike.

Conclusion

The three global powers, the US, Russia, and China, have or are in the process of deploying hypersonic weapons. In future, they may also build some sort of defense against such weapons. Both the hypersonic weapons and their defenses, therefore, will have an impact on the strategic, operational, and tactical levels. At the operational and tactical levels, however, the impact will be more visible with the introduction of hypersonic cruise missiles, especially as part of the Anti-Access and Area Denial (A2AD) strategy and vulnerability of time-sensitive targets, such as road-mobile missiles, air-defense systems, and ships.

Besides, the introduction of hypersonic weapons has already triggered an arms race among the global powers. The US, Russia, and

China are competing for having an edge over their rivals. Soon regional rivals may also be dragged in an arms race. The development of such weapons in India would complicate the security situation in South Asia.

With already weakening global arms control, key states will develop these weapons without any restriction making the non-proliferation of these weapon systems a challenging task. Therefore, banning them or limiting their scope seems to be an unachievable goal in the near future.

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