Centre for Air Power Studies


Centre for Air Power Studies ISSUE BRIEF

146/21

07 September 2021

# MELLOWING THE HYPE OVER HYPERSONIC MISSILES: A PANACEA FOR BALLISTIC MISSILE DEFENCE?

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*Keywords: Hypersonics, Hypersonic weapon system, Hypersonic glider vehicle, Hypersonic cruise missile*

While the hype around hypersonic weapons is new, the idea of using a booster to launch a re-entry vehicle, gliding at hypersonic speed for long distances, dates back to the 1930s.[1] Hypersonic speed has existed since the time Yuri Gagarin re-entered the earth's atmosphere on April 12, 1961. All space shuttles re-entering the atmosphere and ballistic missiles in their re-entry phase travel at hypersonic speed.

**What distinguishes hypersonic glide vehicles is not just speed but also manoeuvrability over long distances. The hypersonic glide vehicles are propelled from a normal ballistic missile.**

When we talk about hypersonic delivery systems, we generally refer to hypersonic glide vehicles (HGVs) and hypersonic cruise missiles.[2] HGVs are re-entry vehicles traveling at hypersonic speed, capable of mid-course manoeuvring, and flying at low heights over long distances. Most of the ballistic missiles are capable of traveling at hypersonic speeds in their terminal phase. What distinguishes hypersonic glide vehicles is not just speed but also manoeuvrability over long distances. The hypersonic glide vehicles are propelled from a normal ballistic missile. Shortly after launch, glide vehicles re-enter the atmosphere, carry out a pull-up to attain equilibrium gliding,[3] and rely on the aerodynamic lift to stay aloft over long range.[4] In proximity to its target, the glider exits the gliding trajectory using internal boosters and impacts the target. On the other hand, hypersonic cruise missiles are manoeuvrable cruise missiles equipped with a scramjet engine. Unlike boost-glide vehicles, hypersonic cruise missiles are powered throughout their flight.

Technology warriors have presented hypersonic missiles as a panacea for missile defence systems.[5] The argument is that fast, manoeuvrable, and low flying hypersonic weapons could penetrate the enemy's missile defences. The perceived vulnerability from a disarming first strike could reduce states' ability to cause unacceptable damage in retaliation, which has made them insecure about their nuclear deterrence. Thus, states have jumped into a hypersonic arms race to counter advances made by their adversaries. The US Department of Defence (DOD), in 2003, initiated a programme to develop fast, long-range conventional strike capability under the Conventional Prompt Global Strike (CPGS). The US is developing two hypersonic gliders—Hypersonic Technology Vehicle-2 (HTV-2) and Advanced Hypersonic Weapon (AHW)—under the CPGS. Beijing tested its first boost-glide vehicle in January 2014 and displayed DF-17, a medium-range ballistic missile capable of launching HGVs, in its 2019 military parade.[6] According to the Russian news agency, in December 2019, Russia deployed its first regiment of hypersonic missile systems named Avangard.[7]

**Undoubtedly, hypersonic missiles are superior to ballistic and cruise missiles and, in some sense, merge the high-speed and long-range capabilities of ballistic missiles with manoeuvrability and low-flying capabilities of the cruise missiles.**

## Mellowing the Hype over Hypersonics

Hypersonic missiles have been dubbed invincible, unstoppable, and missile defence panacea because of their BMD penetrating qualities like speed, in-flight manoeuvrability, accuracy, range, and low-altitude flying ability. Undoubtedly, hypersonic missiles are superior to ballistic and cruise missiles and, in some sense, merge the high-speed and long-range capabilities of ballistic missiles with manoeuvrability and low-flying capabilities of the cruise missiles. However, hypersonic missiles are yet another technological advancement with superior capabilities as compared to their predecessors, not a revolution in deterrence thinking or strategic stability.[8] While fewer hypersonic missiles have a greater chance of penetrating the adversary's ballistic missile defence and air defence than a similar number of ballistic missiles, HGVs are neither unstoppable nor a panacea for missile defence systems. As aptly argued by Colonel Stephen Reny of the US Air Force Academy, "While hypersonic weapons will be better at defeating robust defences than what is available today, they will not be a panacea against missile and ballistic missile defences. Physics is the largest limiting factor in the capability of hypersonic flying."[9]

Speed and manoeuvrability are the two characteristic qualities of hypersonic missiles that contribute or are believed to contribute to their BMD penetrating capability. Because of their low lift-to-drag ratio—which is directly proportional to the range of the glide vehicle—glide vehicles are launched at a very high initial speed, which allows them to have a longer range.[10] However, as they approach the target, due to atmospheric and

aerodynamic resistance and energy lost due to high-speed manoeuvring, the speed of the glide vehicle is reduced and is comparable to short-range ballistic missiles.[11] Thus, it is very likely that glide vehicles are vulnerable to sophisticated missile defences deployed by great powers. James Acton of the Carnegie Endowment for International Peace argues that "the United States has already developed fairly effective point defences... that can defend small areas against ballistic missiles, which are actually moving faster than hypersonic weapons."[12] Moreover, missile defences specific to intercepting hypersonic missiles are already being developed by the United States and Russia. Defence Advanced Research Projects Agency (DARPA) of the US Department of State is building countermeasures against hypersonic missiles under the Glider Breaker Project.[13] Vice Admiral Jon Hill, Director of the US Missile Defense Agency (MDA), recently updated that under its Hypersonic and Ballistic Tracking Space Sensor (HBTSS) initiative, MDA is planning to place satellites and sensor facilities in the low-earth orbit to detect and destroy hypersonic missiles in their glide flight phase. [14] Also, Russia boasts of its S-500 systems capability to intercept hypersonic weapons.[15]

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Hypersonic missiles are capable of flying at low altitudes, but they are not low enough to evade terrestrial radar systems when flying over long distances. For "aerodynamic load and pressure limitations," hypersonic missiles cannot fly at lower altitudes where radar-evading cruise missiles fly.[16] As pointed out by Stephen Reny, "lower altitudes are problematic for hypersonic flight because the lower altitudes overpressure hypersonic engines and prolonged flight creates extreme thermal management issues."[17] Thus, hypersonic missiles have to fly at an altitude higher than 70,000 ft, which makes them vulnerable to radar detection.

As described above, the boost-glide weapons have high initial speed, high enough to convert the surrounding air into plasma and release intense infrared radiations, even perceptible to naked eyes.[18] Thus, the large heat signature of HGVs makes them vulnerable to infrared homing interceptor missiles.

Not just missile defence, other unconventional measures could be and are being adopted to reduce the effectiveness of hypersonic weapons.[19] For example, high-powered GPS jammers could be deployed to create electromagnetic blind zones and thus hampering the accurate targeting capacity of hypersonic weapons. To address the threat of hypersonic missiles, states are developing directed energy weapons such as amplified lasers and high-power microwaves.[20] "High-power microwaves provide area denial capabilities for high-value target areas against hypersonic weapons," argues Heather Venable and Clarence Abercrombie.[21] According to Todd Harrison of the Center for Strategic and International

Studies, with directed energy weapons in place, "you don't have to worry about the time of flight... because the energy beam is going to travel at the speed of light."[22] Thus, it provides the targeted state with enough time to identify the target, resolve warhead and destination dilemmas, and decide to intercept incoming missiles.

**The speed, range, and manoeuvrability of hypersonics are all attributes that will make them preeminent weapons, but that capability will likely not culminate in the penetrating defence panacea.**

It could be critically argued that hypersonic weapons are capable of carrying in-flight terminal manoeuvres and thus evade missile defences. However, manoeuvrability at hypersonic speeds is not all that easy. "One potential challenge for boost-glide weapons is that the high acceleration required for evasive manoeuvring could complicate the reception of GPS signals, potentially undermining accuracy," argues James Acton.[23] Also, even a deflection measured in few minutes at hypersonic speed could generate such large radii having the potential "to throw these swift vehicles miles off course in a fraction of second."[24] Another limitation of manoeuvring at high speed is that it reduces the speed of the glide vehicle, adversely affecting the range and survivability of the vehicle.[25]

To sum up, in the words of Stephen Reny, "The speed, range, and manoeuvrability of hypersonics are all attributes that will make them preeminent weapons, but that capability will likely not culminate in the penetrating defence panacea some literature speculates."[26]

## Hypersonic Weapons and Deterrence Stability

The general understanding of hypersonics posits that the development and deployment of hypersonic missiles would increase deterrence instability and the arms race.[27] The notion of deterrence stability underlines the credibility of nuclear deterrence, mutual vulnerability, and assured second-strike. Hypersonic weapons with their perceived BMD penetrating capabilities offer an attractive option to launch a disarming first strike. Thus, threatening the survivability of the opponent's nuclear deterrence to launch a retaliatory second strike.

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However, hypersonic weapons are not a standalone development but an evolutionary development against the BMDs. The US development of sophisticated BMDs had upset the deterrence stability between the great powers, violating the key nuclear deterrence principle of assured vulnerability. Counterintuitively, hypersonic missiles, with their ability to penetrate BMDs, return the mutual and assured vulnerability

and hence stabilising the strategic deterrence.[28] To be sure, hypersonic missiles do lead to transient crisis instability and arms race due to reduced reaction time and strategic ambiguity. However, the history of the offense-defence spiral indicates that hypersonic missiles will face and indeed are facing counter-measures and may not be destabilising in the longer-term.[29]

## Notes:

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[3] The alignment of local horizontal and velocity vectors in the same direction is referred to as equilibrium gliding.

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[8] Nathan B Terry and Paige Price Cone, "Hypersonic Technology: An Evolution in Nuclear Weapons", S*trategic Studies Quarterly*, vol. 14, no. 2 (2020), p. 75

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[10] Acton, n. 1, pp. 193-194.

[11] Ibid., p. 212.

[12] James M. Acton, "Hypersonic Weapons Explainer", Carnegie Endowment for International Peace, April 8, 2018, https://carnegieendowment.org/2018/04/02/hypersonic-weapons-explainer-pub-75957. Accessed on July 29, 2021.

[13] Sayler, n. 2, p. 10.

[14] Jane Edwards, "Vice Adm. Jon Hill: MDA Pursues Defensive Hypersonic Interceptor Development Effort", EXECUTIVEGOV, August 16, 2021, Vice Adm. Jon Hill: MDA Pursues Defensive Hypersonic Interceptor Development Effort (executivegov.com), accessed on August 17, 2021; Sandra Erwin, "The Pentagon's hyperfocus on hypersonic missile threat", *SpaceNews*, August 25, 2021, The Pentagon's hyperfocus on hypersonic missile threat - SpaceNews. Accessed on August 27, 2021.

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[16] Reny, n. 9, p. 56.

[17] Ibid., p. 57

[18] Ibid.

[19] Acton, n. 1, pp. 214-215.

[20] Congressional Research Service, Defense Primer: Directed-Energy Weapons, Kelly M. Sayler and John R. Hoehn, IF11882, (Washington, DC: Congressional Research Service, 2021).

[21] Heather Venable and Clarence Abercrombie, "Muting the Hype over Hypersonics: The Offense-Defence Balance in Historical Perspective", *War on the Rocks*, May 28, 2019, https://warontherocks.com/2019/05/muting-the-hype-over-hypersonics-the-offense-defence-balance-in-historical-perspective/. Accessed on July 30, 2021.

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[23] Acton, n. 1, p. 213.

[24] Reny, n. 9, p. 58.

[25] Ibid.

[26] Ibid., pp. 59-60.

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[28] Reny, n. 9, p. 48.

[29] Venable and Abercrombie, n. 21.

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