Hypersonics disrupt global strategic stability

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Hypersonic technology offers the potential to strike any point on Earth within an hour. *Heather Williams* examines the impact of current programmes on the strategic balance between the major nuclear powers and the prospect for arms control agreements.

In November 2016, a US Air Force (USAF) committee released the unclassified summary of a report on the advances of hypersonic technology. It had commissioned a Blue Ribbon report, *A Threat to America's Global Vigilance, Reach, and Power: High-Speed Maneuvering Weapons* , by an independent panel of experts. The report expressed concern that not only was the US falling behind in the development of offensive high-speed manoeuvring arms, but also that without action, the country would be vulnerable to future attack by hypersonic weapons.

Although the US hypersonic programme is intended to be purely conventional, the strategic implications of hypersonic technology have not been lost on other nuclear-armed states. For example, Russia and China are both pursuing hypersonic glide vehicle (HGV) programmes that maintain the option of mounted nuclear warheads, and countries such as India have also embarked on hypersonic programmes.

Emerging applications

HGVs are part of a class of emerging hypersonic weapons, which also includes hypersonic cruise missiles (HCMs). These weapons can travel five times faster than the speed of sound (Mach 5) or faster, reaching speeds of approximately 6,126 km/h and above. Although such weapons are yet to become commonplace, HGV range estimates of approximately 8,000 km are common.

In addition to their speed, HGVs are unique in their manoeuvrability. Unlike ballistic missiles, which tend to travel in predictable trajectories and cannot be redirected or guided, HGVs offer the potential to change direction mid-course, evade missile defences, and travel at low altitudes. This is because rather than being fired from the Earth's surface, an HGV is carried on a booster vehicle to the edge of Earth's atmosphere where, after separation, the vehicle then 'glides' back into the atmosphere.

Although US research into boost-glide technology first began in the late 1940s, the United States announced a renewed interest in advanced conventional weapons, a platform known as 'Prompt Global Strike', as a policy objective in the early 2000s. This programme aligned with the 2002 Nuclear Posture Review (NPR) and was part of a 'new triad' that covered offensive strike weapons (both conventional and nuclear-armed), active and passive defences, and revitalised defence infrastructure.

Indeed, despite its name, the 2002 NPR was distinct in its lack of exclusive nuclear focus and was more of a broad strategic and defence document. In the environment after the 11 September 2001 attacks on the US, the requirement to be able to strike anywhere in the world within an hour was envisaged to be used for counter-terrorism-related targeted killings.

The US Advanced Hypersonic Weapon demonstrator was launched successfully on its first flight in 2011, but failed a key test on 25 August 2014. A US Air Force-commissioned report criticised the slow development of such technology in the defence of the country. (US Army) 1528895

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Upsetting the balance

Although US HGVs will not carry nuclear weapons, the strategic impact of the technology is clear to other nuclear powers. As a result, in 2013, Russian president Vladimir Putin explained in his state of the nation address that HGVs could "negate all previous agreements on the limitation and reduction of strategic nuclear weapons, thereby disrupting the strategic balance of power".

For many theorists, this "balance of power" stems from the traditional concepts of offence-defence balance that rose to prominence with the dawn of the missile age. With the advent of long-range missiles, the superpowers were, for the first time, able to launch numerous nuclear warheads against each other. However, there was no benefit in striking first because as long as both sides had survivable nuclear assets, any nuclear launch would be reciprocated. As both sides remained vulnerable to nuclear attack, they were deterred from using nuclear weapons and entered a strategically stable relationship.

HGVs could challenge this orthodoxy as states such as the US move towards the capability to credibly target an adversary's deterrent with non-nuclear weapons, the protection of which has traditionally required targeting with nuclear weapons. This potential is particularly acute in states such as Russia and China, which have traditionally placed a greater reliance on land-based delivery systems that may be more susceptible to HGV systems.

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Russian HGVs

With the trauma of the collapse of the Soviet Union in 1991, it is unsurprising that Russia's definition of strategic stability is much broader and encompasses other 'domains' alongside the traditional nuclear aspects, including the economic and social. Despite this broader perspective, nuclear weapons remain integral to Russian strategy and are inseparable from the other domains.

A screenshot of the leak of the Russian Okeanskaya Mnogotselevaya Sistema 'Status-6' (Kanyon) high-speed nuclear torpedo concept. (Russian State Media)

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As the Russian military has recovered since its post-Cold War low, the asymmetry between its armed forces and those of the US has not only driven military modernisation efforts but also shifted Russia's doctrine in coping with its primary competitor. For Russia, the US is far superior conventionally and therefore Russia must rely more heavily on its nuclear weapons to counter perceived regional threats, while maintaining its ongoing nuclear modernisation programmes to maintain strategic parity with the US. With verification under the 2010 New Strategic Arms

Reduction Treaty (the New START Treaty) due to expire in 2021 and limited prospects for further arms control, there is no clear pathway for restraining Russia's continued emphasis on nuclear weapons.

From Russia's perspective, regional missile defences, such as NATO's European Phased Adaptive Approach (EPAA) missile defence system, or the US's national Ground-Based Midcourse Defense (GMD) system have the potential to undermine the credibility of Russia's nuclear deterrent unless Moscow finds a means of overcoming and penetrating such missile defences. With a reported range of 9,900 km, Russia's Yu-71 has the potential to do just that. According to the US, EPAA is not directed at Russia, but was instead developed and deployed with threats from the 'south-east' in mind. Nonetheless, Russia's perception of the threat to its arsenal from missile defence has prompted the pursuit of HGVs and other forms of military diversification.

As previously reported in *IHS Jane's Intelligence Review* in June 2015, Russia's efforts to develop a modern HGV centre around the Yu-71, also known as Project 4202. Other Russian hypersonic work includes a second experimental HGV - the Yu-74 - which flew in 2016 from the Dombarovskiy test site, near Orenburg, and landed on target at the Kura test site, Kamchatka, and the short-range 3M22 Zircon HCM, which is expected to enter into production in 2018. Russia's modern hypersonic efforts may also reach back to 2001 when it tested an SS-19 'Stiletto' (UR-100N) intercontinental ballistic missile (ICBM) that could have included a glide vehicle. Project 4202, with the Yu-71 vehicle, was first tested in 2011. There were several other tests before its first successful test in April 2016. According to the Sputnik news site (which has close links to the Kremlin) in 2016, at least 20 Yu-71 HGVs will be produced, with three per booster missile, thought to be the new RS-28 Sarmat, which is due to gradually replace the SS-19. The same news source suggests the Sarmat will also be capable of carrying up to 24 Yu-74 HGVs.

Given Russia's shift towards an increasingly diversified military strategy, Moscow's focus on hypersonic technology ensures that both nuclear and conventional strike options will remain available in the face of ballistic missile defence (BMD), and helps to ensure the flexibility required by an interconnected doctrine that blends conventional and nuclear forces. In addition to flexibility, while rebuilding its conventional capabilities Russia has increasingly relied on nuclear weapons as a continued symbol of great power status. Hypersonic technology consolidates both trends by ensuring the continued relevance of Russia's nuclear arsenal and at the same time bolstering its military prestige in the sense that it is not only keeping up with the US and China, but may even be surpassing them. Speaking in 2014, Boris Obnosov, head of Russia's Tactical Missiles Corporation, said in a news interview, "In my estimation, the first hypersonic products should appear … in this decade before 2020." This estimate was reiterated in 2016.

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Chinese HGVs

By incorporating nuclear weapons into a broad security framework that includes conventional and cyber capabilities, China shares similar concepts of strategic stability with Russia. Although Beijing has traditionally placed an emphasis on minimum deterrence, developments such as the nuclear-capable DH-10/CJ-10 land-attack cruise missile suggest a greater regional prominence for its nuclear weapons.

China has also made significant headway in its HGV programme. In April 2016 it conducted its seventh HGV test with the DF-ZF (WU-14) vehicle. Subsequent reporting suggests this was probably carried on a DF-21 CSS-5 medium-range ballistic missile with a range of more than

2,000 km, although it may eventually be developed for longer-range missiles such as the DF-31 with ranges of more than 8,000 km.

The CASIC Kuaizhou-1 mobile solid fuel space launch vehicle and its transporter could form the basis for a strike system using a version of the DF-ZF hypersonic manoeuvring vehicle. (Chinese internet)

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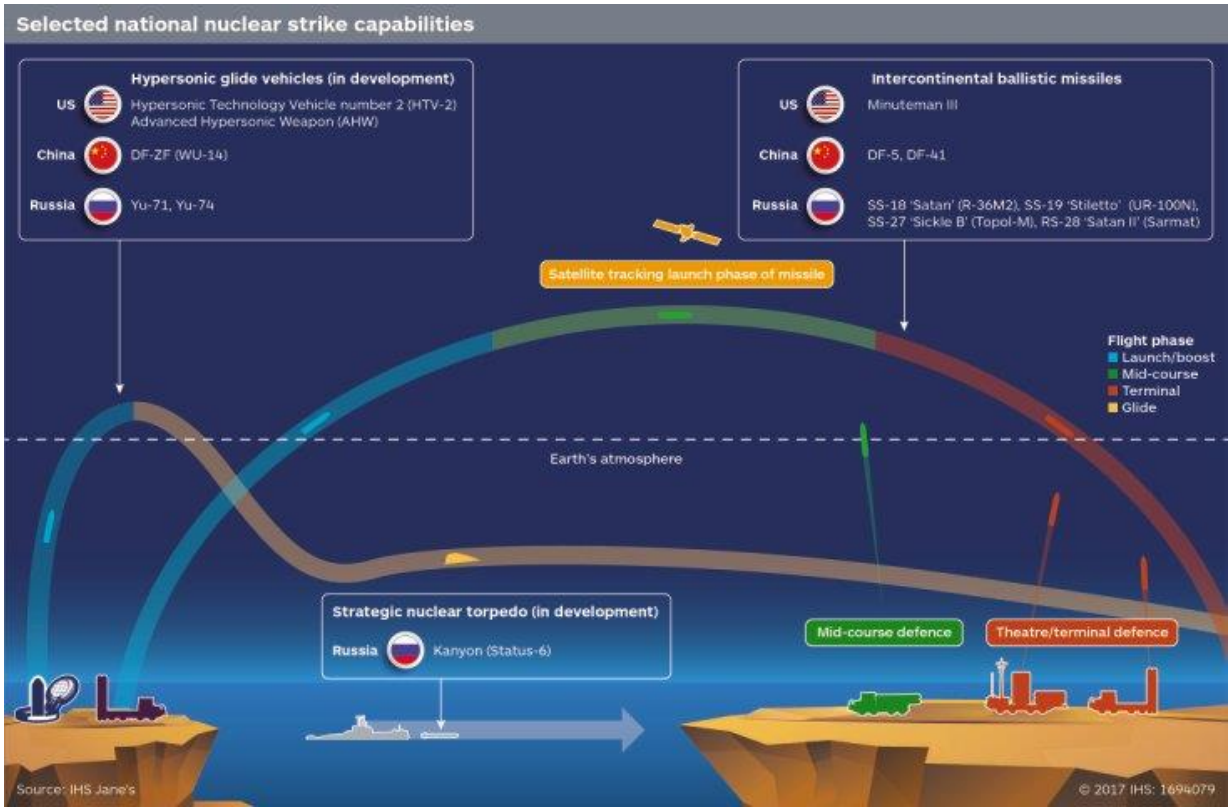
Ambiguous futures

Given the significant technological advances and financial investments, HGV development has all the appearances of an arms race between the major nuclear powers. An arms race can happen for a variety of reasons, although in the case of Russian and Chinese HGVs, it is directly tied to rebalancing the offence-defence relationship with the US and draws on new technologies as an asymmetric response to US conventional (and in the case of China, nuclear) superiority. In turn, the USAF Blue Ribbon report expressing concern that "potential adversaries are already designing systems that exploit both organizational disconnects and current defensive technical limitations within the United States" recommends increased US investment and cross-department co-ordination to keep pace with developments in Russia and China.

Although the HGV arms race itself is driven by a need to rebalance perceptions of strategic stability, as James Acton of the Carnegie Endowment for International Peace has argued, the race itself also comes with numerous challenges to strategic stability. First among these is warhead ambiguity, whereby a nuclear-armed HGV would be indistinguishable from a conventionally armed variant. The US initially defended its pursuit of conventionally armed HGVs by arguing that their trajectory was distinct from that of nuclear-armed ICBMs, so adversaries would be able to identify the attack as non-nuclear. However, given that Russia and China are likely to arm their HGVs with a combination of nuclear and conventional weapons, such distinctions are unlikely to persist.



Selected national nuclear strike capabilities (©2017 IHS)

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In addition to being unable to distinguish the nature of any threats faced, HGV use runs the risk of other states being unable to identify the vehicle's target. This destination ambiguity complicates national defence mechanisms and response options, both nationally and internationally, and may prompt miscalculation as states assume the worst-case scenario, or neighbouring states wrongly believe that they are under attack. The risks posed by such ambiguity are not only enhanced by the high speeds of HGVs, which mean less time for decision-makers and greater pressure for crisis escalation, but may become more frequent if HGVs are conventionally armed and are considered more usable, particularly given their level of precision in targeting.

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What to watch

An ongoing arms race for this emerging technology will require significant and sustained financial investment by all, suggesting such a scenario would seem ripe for arms control. According to the arms control theory advanced by Thomas Schelling and Morton Halperin in 1961, arms control served several functions, including the promotion of strategic stability, reducing the risk of conflict, reducing the damage if conflict occurred, and reducing defence costs. Academic Mark Gubrud has suggested one option for HGV arms control in the *Bulletin of the Atomic Scientists* whereby states would agree not to further test HGV technologies. Given the amount of investment already put into research and development, along with the perceived strategic gains by Russia and China in particular, the circumstances for HGV arms control are not ideal.

Acton has suggested that Russia may be developing HGVs as leverage for future arms control negotiations with the US. Indeed, the US's advanced conventional capabilities were a point of contention during negotiations for the New START Treaty, whereby Russia wanted to see these

included in the treaty's counting rules. The resolution was that all ICBMs and submarine-launched ballistic missiles, whether armed with nuclear or conventional weapons, were counted under the New START Treaty, with the exception of boost-glide vehicles. Russia probably agreed to these terms as it was already pursuing Project 4202 and in light of US withdrawal from the Anti-Ballistic Missile (ABM) Treaty in 2002.

Hypersonic glide vehicles and missiles

Missile	Country	Type	Anticipated specification
Hypersonic Technology Vehicle number 2 (HTV-2)	US	HGV	Intercontinental
Advanced Hypersonic Weapon (AHW)	US	HGV	Intercontinental
Yu-71	Russia	HGV	Intercontinental
Yu-74	Russia	HGV	Intercontinental
Zircon	Russia	HCM	Sea-launched cruise missile
DF-ZF (WU-14)	China	HGV	Intercontinental
DF-ZF (WU-14)	China	HGV	Intercontinental
BrahMos-II	India	HCM	Sea-launched cruise missile
Shourya/Sagarika (K15)	India	Hypersonic hybrid	Surface-to-surface ballistic missile – reporting suggests the missile can fly a hypersonic glide, pure ballistic, or ballistic with later glide

Source: IHS Jane's

Hypersonic glide vehicles and missiles (©2017 IHS)

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New START acknowledges the link between offence-defence in its preamble; however, whereas Russia perceives this as a binding commitment with implications for US advanced conventional weapons, according to the US the preamble is non-binding. Given Russia's own growing interest in advanced conventional weapons, the ambiguity will probably either be ignored or serve as a political tool for Russia at a future date.

In lieu of arms control on HGVs, stopping or slowing the arms race would require Russia and China to identify other means of countering US missile defences. For its part, the US seems undecided as to what role HGVs will play and how much it wants to invest in further testing and development. One option would be a return to missile defence arms control. This comes with numerous challenges, including the US's commitments to its allies and strong domestic support for missile defence. Additionally, although there is a history of arms control on missile defence with the 1972 ABM Treaty, that only applied to national missile defences, rather than regional ones, which are the source of concern for both Russia and China. A second option would be technical methods for overcoming missile defences, such as flares, the use of cyber to interfere with missile defence systems and communications, and other countermeasures. However, this merely shifts the arms race from offensive HGV capabilities to increasingly sophisticated missile penetration aids.

Last, and perhaps most pessimistically, would be the use of an overwhelming surprise attack.

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Conclusion

When it comes to strategic stability, perception matters. Both Russia and China, with conventional inferiority to the US, perceive a strategic gain from HGVs that offer speed and manoeuvrability to evade US missile defences.

Although HGVs are yet to become commonplace, the HGV arms race is already a reality given Chinese, Russian, and US interest. With the potential to reach anywhere on Earth within an hour, HGVs are increasing the speed at which conflict can occur.

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