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The hypersonic threat to the United Kingdom

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On 1st March 2018, Vladimir Putin, President of Russia, gave his annual 'State of the Nation' speech. This was different to previous speeches in that extensive time was devoted to providing an update on Russia's military power, including a great deal of emphasis on new Russian 'superweapons'. Putin said that:

> We started to develop new types of strategic arms that do not use ballistic trajectories at all when moving toward a target and, therefore, missile defence systems are useless against them, absolutely pointless...we will make the necessary efforts to neutralise the threats posed by the deployment of the US global missile defence system.[1]

He was referring to Russia's new hypersonic missile (see Box 1), the Avangard.[2] In the years since 2018, both Russia and the People's Republic of China (PRC) have developed and brought into service a growing collection of hypersonic

[1] Robert Coalson and Carl Schrek, 'Putin's State of the Nation Speech', *Radio Free Europe*, 01/03/2018, https://www.rferl.org/ (checked: 23/01/2024).
[2] The Avangard itself is a HGV, currently deployed on the SS-19 Stiletto ICBM, though Russia plans to eventually launch the vehicle from the Sarmat ICBM. See: 'Hypersonic Weapons: Background and Issues for Congress', Congressional Research Service, 13/02/2023, https://sgp.fas.org/ (checked: 23/01/2024).

weapons. With strategic interests in stark contrast to those of Russia and the PRC, the United Kingdom (UK) – one of the foremost supporters of the open international order – should consider carefully the risks posed by these supposedly 'unstoppable' weapons.

Box 1: What are hypersonic weapons?

Hypersonic weapons travel at speeds in excess of Mach 5 (five times the speed of sound) inside the atmosphere for most of their trajectory. Travelling at these speeds for a *sustained* period *within* the atmosphere differentiates hypersonic weapons from ballistic missiles, which are also capable of exceeding Mach 5. Hypersonic missiles must contend with different flight conditions than ballistic missiles or subsonic and supersonic missiles, such as extreme heat. There are two types of hypersonic weapon:

- Hypersonic Cruise Missiles (HCMs): are similar to subsonic and supersonic cruise missiles and fly a non-ballistic trajectory. HCMs require a special engine (a ramjet or a scramjet capable of Mach 6 and Mach 10+ respectively), but these engines require a high speed to operate and therefore HCMs need a booster to get them up to speed. In addition, scramjets must maintain a minimum altitude of roughly 12.5 miles to generate the necessary air pressure for the engine to function.

- Hypersonic Glide Vehicles (HGVs): A glide vehicle is launched from a booster, once the booster has reached the desired speed and altitude the glide body separates and flies unpowered (in the upper atmosphere at altitudes of 20–50 miles) towards the target.

For a more detailed explanation of hypersonic missiles from a more technical perspective, please see our previous Explainer entitled *Hypersonic weapon systems: High expectations*.[3]

This Explainer explores how Russia and the PRC envision using their hypersonic weapons and what the hypersonic threat to the UK is. It begins by explaining why Russia and the PRC are pursuing hypersonics and where these new missiles fit into their military doctrines. The paper then goes on to explore

[3] Gabriel Elefteriu and William Freer, 'Hypersonic Weapon Systems: High Expectations', Council on Geostrategy, 05/12/2023, https://www.geostrategy.org.uk/ (checked: 23/01/2024).

the threats from hypersonics facing the British Isles and those faced by the British Armed Forces abroad, both in the Euro-Atlantic and the Indo-Pacific.

Why hypersonics? Russian and Chinese military doctrine

From the end of the Cold War until the mid-2010s, free and open nations enjoyed military dominance on the cheap. Defence expenditure was reduced – ten years on from the collapse of the Berlin Wall, British and American defence spending had dropped from 4.0% and 5.6% of Gross Domestic Product (GDP) to 2.4% and 3.1%, respectively – because there were no state-based rivals capable of mounting a serious challenge.[4] Things began to change from roughly 2008 onwards with the Russian invasion of Georgia.[5] As a result of a combination of the distraction of the War on Terror, the meteoric growth of the PRC's economy, and Russia's rebuilding from the post-Soviet collapse, two serious challengers to the prevailing order have risen. Russia, seeking to disrupt this order, increased its defence spending from £36 billion in 2008 to £57 billion in 2022 (with a planned increase to £96 billion for 2024) and the PRC, seeking to displace the existing order – for now regionally, but potentially more widely as its power increases – saw its defence spending increase from £89 billion in 2008 to £237 billion in 2022 (all figures in constant 2022 pounds sterling).[6]

With such large increases in defence expenditure, the PRC and Russia have been closing the gap in the military balance with a substantial buildup of modern conventional equipment, but (for now) the gap still remains. Yet hypersonics are incredibly expensive to develop and manufacture – since 2019 the US has spent £6.3 billion on hypersonic programmes with another £10.2 billion earmarked for 2023-2027 and the unit cost for the LRHW ('Long Range Hypersonic Weapon' the US Army's HGV) is estimated at over £32 million.[7] This raises the question of why the Russians and the Chinese seem to be investing so much effort in the development of hypersonic weapons. There is a high opportunity cost in what could be invested in the further build up of other platforms (such as additional

[4] 'Military Expenditure Database', Stockholm International Peace Research Institute, No date, https://www.sipri.org/ (checked: 23/01/2024).
[5] Peter Dickinson, 'The 2008 Russo-Georgian War: Putin's Green Light', Atlantic Council, 07/08/2021, https://www.atlanticcouncil.org/ (checked: 23/01/2024).
[6] 'Military Expenditure Database', Stockholm International Peace Research Institute, No date, https://www.sipri.org/ (checked: 23/01/2024).
[7] Kelley M. Sayler, 'The US Army's Long-Range Hypersonic Weapon (LRHW)', Congressional Research Service, 15/09/2023, https://crsreports.congress.gov/ (checked: 23/01/2024).

aircraft, warships, or subsonic/supersonic missiles). The answers lie in where hypersonics fit into Russian and Chinese military doctrine.

Russian military doctrine

Russia's development of hypersonic missiles has focused on a dual-use purpose between the conventional and nuclear roles. A key part of the modernisation of Russia's nuclear arsenal has included the development of nuclear capable hypersonics (such as the Avangard HGV).[8] Both Russia and the PRC view US Ballistic Missile Defence (BMD) capabilities as a threat to their traditional ballistic missile strike options, as Putin referenced in his 2018 speech. Russia already possesses a significant number of Intercontinental Ballistic Missiles (ICBMs), such that they should be able to overwhelm US BMD even without the addition of hypersonic missiles – certainly in a first-strike scenario and also likely in a second-strike scenario.[9] In the realm of nuclear deterrence, hypersonics have in part been developed to hedge against *future* BMD developments, with the US constantly improving its capabilities.[10] But due to the expense of these systems and limited Russian resources, it is likely that the Avangard and other systems will act as an addition to Russia's ballistic missile stockpile (both long-range and short-range) rather than an eventual replacement.

In addition to enhancing and future proofing their nuclear deterrent, the Russians have envisioned (as seen in the Zircon missile – although beyond Russian reports there is no confirmation that it is in fact hypersonic) an important role for hypersonic missiles in conventional warfare.[11] They believe the damage conventionally armed hypersonics could achieve, in targeting critical (and well defended) nodes such as Command and Control (C2) centres and missile defence platforms, is key to the future of their conventional deterrence; especially as the missile defences of North Atlantic Treaty Organisation (NATO) members continue to improve. This is a continuation of Russia's military

[8] Note the Kinzhal is classified as a hypersonic missile by the Russians and is also dual-use, but is more accurately described as an aero-ballistic missile. It is essentially a modified air-launched version of the Iskander ballistic missile. And it should also be noted, despite allegedly entering service in 2019, no picture (beyond artist's impression) of the Avangard has ever materialised.
[9] Paige P. Cone, 'Future Warfare Series No. 59: Assessing the Influence of Hypersonic Weapons on Deterrence', United States Air Force Centre for Strategic Deterrence Studies, 06/2019, https://media.defense.gov/ (checked: 23/01/2024).
[10] For example including the allocation of around £3.5 billion over the next four years for Aegis development alone. See: 'Navy Aegis Ballistic Missile Defense (BMD) Programme: Background and Issues for Congress', Congressional Research Service, 20/12/2023, https://s3.documentcloud.org/ (checked: 23/01/2024).
[11] Sidhart Kaushal, 'The Zircon: How Much of a Threat Does Russia's Hypersonic Missile Pose?', Royal United Services Institute, 24/01/2023, https://www.rusi.org/ (checked: 23/01/2024).

doctrine of 'active defence'.[12] The idea being that a mass hypersonic attack early in a conflict would sow chaos and open up vulnerabilities in an adversary.[13]

Chinese military doctrine

The PRC is currently testing, developing, and has already deployed a range of hypersonic systems that could give it the capacity to launch damaging theatre-level strikes against the territories and bases of adversaries (such as the UK and the US) in the Indo-Pacific. However, for example, the PRC already possesses the capability to destroy US *fixed* infrastructure in the Western Pacific with massed ballistic missile attacks which would overwhelm America's BMD. The main differences are that hypersonic attacks would provide the US with less warning and therefore have a greater element of surprise (albeit by a matter of a few minutes) and that they provide the potential for more complex sequences of strike packages.[14] The other use for hypersonic missiles in PRC strategic thought is to present a long-range threat to enemy naval forces in the Indo-Pacific. In theory, the threat of hard to detect and intercept DF-ZFs (a Chinese HGV) would force enemy navies to operate further from the Chinese coastline. Hypersonic missiles would provide the spearhead of the People's Liberation Army's (PLA) Anti-Access/Area Denial (A2/AD) posture.

The PRC believes hypersonics will provide greater reach and lethality to its A2/AD umbrella. The PRC has attached the DF-ZF, a HGV which became operational around 2019-2020, to the DF-17 and now also the DF-27 ballistic missiles (with ranges of 1,120-1550 miles and 3,100-4,970 miles, respectively).[15] Yet, the PRC already possesses long-range anti-ship ballistic missiles such as the DF-26 with an estimated range of 1,860-2,485 miles and the DF-21 with a range of 1,300 miles.[16] Clearly, Beijing's new weapons do not increase their reach by a significant margin (although reaction times *are* significantly reduced) – but this could be overcome if the PRC follows the Russians in testing the deployment of hypersonic weapons on submarines.

In terms of lethality, hypersonics enhance but do not fundamentally revolutionise the capabilities of the PLA. Against a stationary target (such as

[12] Roger Mcdermott, 'The Role of Hypersonic Weapons in Russian Military Strategy', Jamestown Foundation, 04/02/2022, https://jamestown.org/ (checked: 23/01/2024).
[13] *Ibid.*
[14] The distance from Guam to the Chinese mainland is roughly 3,000km, over this distance a ballistic missile launch would give, (to a ground based radar at the target site) roughly 12 minutes warning, whereas a HGV launch would give roughly six minutes warning.
[15] 'Hypersonic Weapons: Background and Issues for Congress', Congressional Research Service, 13/02/2023, https://sgp.fas.org/ (checked: 23/01/2024).
[16] 'Today's Missile Threat: China', Missile Defence Advocacy Alliance, 01/2023, https://missiledefenseadvocacy.org/ (checked: 23/01/2024).

naval/air bases or fixed missile defences), hypersonics would be more likely to destroy their targets than ballistic missiles – as they are harder to detect and intercept through a combination of flight path, speed, and manoeuvrability – but (as already stated) the PRC possesses sufficient ballistic missiles to swamp US BMD. However, when it comes to moving targets, such as a US Navy carrier strike group, hypersonics could be more lethal than ballistic missiles. This again comes from their improved manoeuvrability and the difficulty of interception, which raises the prospect of running down the defending ship's vertical launch magazine depth at a faster pace as multiple missiles may be needed to score a kill. But doubts still remain about the accuracy of hypersonics on moving targets – due to the inherent difficulty of accuracy at intense speed and the problems with targeting due to the generation of a plasma layer which interferes with signals to and from the weapon.

The threat to the UK and to the British Armed Forces

Both Russia and the PRC view hypersonic missiles as enhancing their existing doctrines, conventional and nuclear. Despite continuing doubts as to their effectiveness, the development of these new weapons – and the fact that other actors (such as Iran) are attempting to acquire them – poses growing risks to Britain's globally-deployed armed forces and the British home islands.

Hypersonic threat in the Euro-Atlantic

Since the beginning of the Cold War, the primary concern for British defence planners has been managing the threat from the Kremlin, whether it was the past expansionism of the Soviet Empire or the contemporary revanchism of Putin's regime. Over time new threats have emerged from the eastern fringes of Europe which have required reaction to maintain a military advantage over the Soviets/Russians. The same is true vice versa; often NATO members develop new military capabilities which the Russians are forced to react to in order to avoid falling too far behind. This game of 'cat and mouse' (see Table 1) coming from developments in strategy or technology has been a constant feature of competition between NATO and the Kremlin. There was a lull in the 1990s, but it has heated up once more. Hypersonics are one of the next stages in this competition.

Table 1: The game of 'cat and mouse' – examples of Soviet/Russian and British developments and reactions over time

Development	Reaction
1945: Large Red Army stationed from Stettin to the Adriatic in the aftermath of the Second World War with a shattered Europe lying before them.	**1945:** Creation of the British Army of the Rhine to forwardly-deploy British land forces in Germany, to help provide a shield against Soviet aggression.
1949: Soviets successfully test their first nuclear device with an operational weapon following shortly.	**1952:** The UK successfully tests its own nuclear device, ensuring that it can independently deter a Soviet nuclear attack.
1951: The Canberra bomber enters service with the Royal Air Force (RAF), it is capable of extremely high altitude flight and is almost impossible to intercept.	**1957:** The Soviets introduce the S-75 SAM system specifically designed to shoot down high altitude aircraft.
1969: The Harrier jump jet enters service with the British Armed Forces, a technological marvel capable of dispersed operations from almost any flat surface.	**1976:** After years of trying to prove they can also design a jump jet and at great expense, the Yak-38 enters service with the Soviet armed forces.
Early 1970s: Massive build-up of the Soviet Navy, particularly modern nuclear attack submarines which seriously threaten NATO's control of the sea and the vital supply lines between Europe and North America.	**Later 1970s:** The Royal Navy alters its posture from one of global power projection centred on large aircraft carriers and cruisers to one focused on anti-submarine warfare centred on light carriers and frigates.
Late 1990s: Dominant NATO air and naval superiority enables massed long-range precision strike capabilities which can cripple Russia's outmoded forces.	**Early 2000s:** Russian development of A2/AD doctrine centred on layers of defensive missile firepower designed to keep NATO's air and naval strength away from key defence infrastructure.

Russia's growing arsenal of hypersonic missiles is one element of the Kremlin's long standing attempts at introducing supposedly 'game-changing' weapons designed to give Russia military advantage at the tactical, operational, or strategic level and/or force NATO into expending resources in developing capabilities that can counteract them. For the UK, the Russian hypersonic threat in the Euro-Atlantic is threefold:

- **The nuclear threat to the home islands:** In theory, the British Isles are more vulnerable than ever to a nuclear strike ordered by the Kremlin. Hypersonic weapons are more difficult to detect, track and intercept than existing ballistic missiles. But the UK only possesses limited BMD sensor capabilities, including as part of the NATO BMD System. For example, RAF Fylingdales hosts a US early warning radar facility (capable of detecting

objects 3,000 miles into space) which is operated by British personnel.[17] Currently, the UK lacks its own dedicated ballistic missile interceptor, but the Royal Navy's Type 45 destroyers are being upgraded to receive BMD capabilities based on the Aster 30 Block 1 missile.[18] The UK is already vulnerable to a concerted Russian ballistic missile strike and protection comes not from ability to intercept (with a nuclear strike far fewer missiles need to survive to have significant destructive impact compared to conventionally armed missiles), but from the Continuous at Sea Deterrent, the Royal Navy's ballistic missile submarines – capable of launching a devastating retaliatory strike. It is the threat of this retaliation which truly deters Russia from using its own nuclear weapons (tactical or strategic) on the UK itself, hypersonic or otherwise.

- **Conventional strikes on key nodes:** Where the UK is more vulnerable to hypersonic weapons is in conventional warfare. Hypersonic missiles look set to provide the tip of the spear for the Russian doctrine of active defence. Any conflict with NATO would involve Russia using an early wave of missile strikes designed to deal heavy damage to critical NATO military nodes such as C2 sites and other critical infrastructure. Hypersonics would be used to target key missile defences (such as radars and launch sites) to enable a greater number of Russia's slower missiles to reach their targets. British forces deployed with NATO would be vulnerable, but NATO does possess limited counter-hypersonic capabilities (primarily through sophisticated US BMD systems with nascent counter-hypersonic capabilities, e.g., THAAD, Aegis, and Patriot PAC-3).[19]

- **Strikes on naval platforms:** Similarly, Royal Navy warships – which owing to the nature of the waters they would be operating in (the North, Baltic, and Mediterranean seas) would be well within range of long-range Russian missiles, and be vulnerable to Russian hypersonics. Currently, no Royal Navy warship possesses counter-hypersonic systems, although the Type 45 destroyers are due to receive a BMD upgrade which will likely give them nascent counter-hypersonic capabilities.[20] The difference between hypersonic strikes at sea is that Royal Navy warships can move and, as

[17] 'RAF Fylingdales', Royal Air Force, No date, https://www.raf.mod.uk/ (checked: 23/01/2024).
[18] 'DE&S secure Type 45 Ballistic Missile Defence Upgrade', Ministry of Defence (UK), 24/05/2022, https://des.mod.uk/ (checked: 23/01/2024).
[19] Richard R. Burgess, 'Vice Adm. Hill: MDA Pushes Space-Based Sensor for Tracking Hypersonic Missiles for Fleet Defense', *Seapower: The Official Publication of the Navy League of the United States*, 02/02/2022, https://seapowermagazine.org/ (checked: 23/01/2024).
[20] 'Upgrading the Royal Navy's Type 45 Destroyers', *Navy Lookout*, 04/04/2022, https://www.navylookout.com/ (checked: 23/01/2024).

mentioned earlier, a hypersonic missile travelling at incredibly high speeds makes hitting a moving target very difficult.[21] This means a hypersonic system must either slow down to track a moving target, negating a degree of its speed advantage, or accept decreased accuracy.

Hypersonic threat in the Indo-Pacific

The threat to the UK from hypersonic missiles in the Indo-Pacific comes from their possible use by the PRC against Royal Navy warships. The likelihood of the PRC becoming involved in a war with any of the neighbouring countries with whom it has a territorial dispute is hotly debated; even more hotly debated is the possibility that the US could become involved. But if such a situation were to occur, it is difficult to imagine that the US would not call on the UK for support and that this support would not be forthcoming. It is important therefore, for British defence planners to consider what threats they might face in such a scenario.

In the event of conflict which involved the PRC on the one side and Britain (supporting allies and partners) on the other, the Royal Navy would bear the brunt of the UK's contribution. It is impossible to say exactly how the fighting would occur or why, but whatever conflict could be sparked it would be an inherently maritime one. The PRC's layered and powerful A2/AD network would likely prevent Royal Navy warships (excluding submarines) from operating deep within the South or East China seas – or perhaps even limit surface ships to operating beyond the First Island Chain (the insular line running from Japan, through the Philippines to Borneo and then to Singapore). Most of the PRC's A2/AD firepower comes from shorter range missiles such as the YJ-12, but the PRC has in recent years sought to extend the reach of its A2/AD capabilities through anti-ship ballistic missiles and hypersonic systems. This means that even operating *beyond* the First Island Chain, Royal Navy warships could come under attack by hypersonic missiles.

The PRC claims that its DF-ZF is capable of striking moving targets (such as warships), but this is yet to be demonstrated. It is unclear what guidance systems Chinese hypersonics currently utilise: there are several possibilities ranging from inertial guidance (which would allow the missile to guide itself to immobile targets) to satellite assisted guidance. However, despite serious doubts over the accuracy of the PRC's hypersonic arsenal, it is likely that over time it will improve – although due to the formation of plasma there may come a hard ceiling on top speed where accuracy can be assured – and therefore, the Royal

[21] Roger Mcdermott, 'The Role of Hypersonic Weapons in Russian Military Strategy', Jamestown Foundation, 04/02/2022, https://jamestown.org/ (checked: 23/01/2024).

Navy needs to consider how it will deal with this threat. The alternative to inaction would be either becoming a bystander in a conflict of vital importance, or the prospect of multiple warships being sunk before they can even fire a shot in response.

Conclusion

The threat from hypersonics is, for now, unclear. Russian and Chinese propaganda cannot be believed and there is limited data available from observations of tests. However, the threat will only grow as the technology behind hypersonic missiles matures. Consequently, ensuring that British military facilities and forces are sufficiently covered by radar and missile defence systems capable of detecting, tracking, and intercepting hypersonic weapons is becoming a concern. To meet the future threat and generate strategic advantage, HM Government should accelerate its exploration of both hypersonic and counter-hypersonic systems and multiply the effort through deeper collaboration with similarly interested allies and partners.[22]

This Explainer is part of the Council on Geostrategy's ***Strategic Advantage Cell****.*

[22] Gabriel Elefteriu, William Freer and James Rogers, 'What is strategic advantage?', Council on Geostrategy, 23/11/2023, https://www.geostrategy.org.uk/ (checked: 23/01/2024).

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