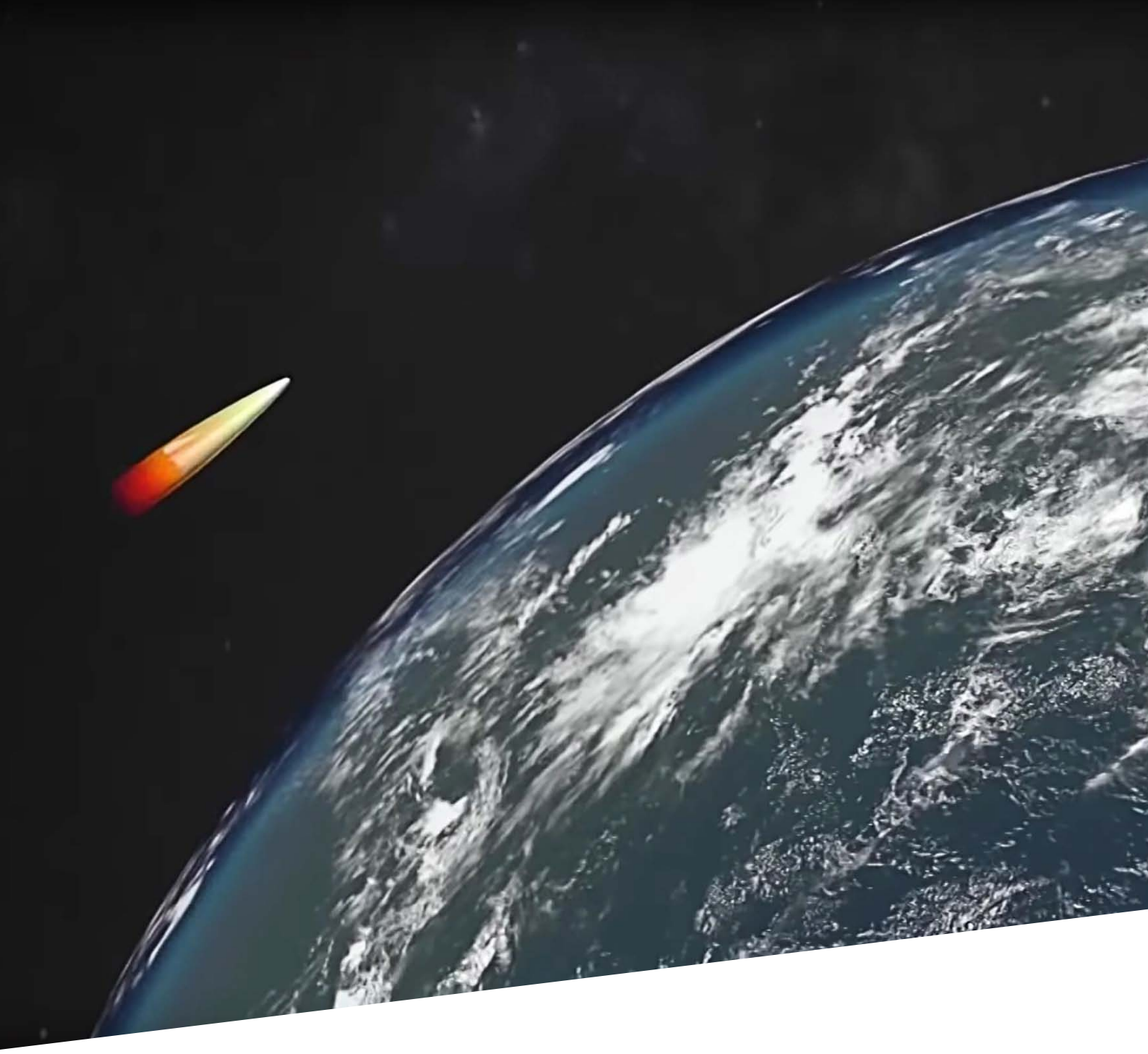

Analysis

NATO's Hypersonic Challenge

| Richard Weitz |

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63/4 Narva Rd., 10120 Tallinn, Estonia
info@icds.ee, www.icds.ee

About the Author

Richard Weitz

Richard Weitz is a senior fellow and director of the Center for Political-Military Analysis at the Hudson Institute. His current research includes regional security developments relating to Europe, Eurasia, and East Asia, as well as US foreign and defence policies. Before joining Hudson in 2005, he worked at the Institute for Foreign Policy Analysis, the Center for Strategic and International Studies (CSIS), the Defense Science Board, Harvard University, and the U.S. Department of Defense. He received his Ph.D. in political science from Harvard University, M.Phil. in politics from Oxford University, M.Sc. in international relations from the London School of Economics, and B.A. with highest honours in government from Harvard College.

Introduction

The hypersonic age has come to European defence. Russia and other European militaries are researching, developing, and starting to deploy hypersonic delivery systems, which travel five or more times the speed of sound. Moscow's hypersonic delivery vehicles – including both hypersonic glide vehicles (HGV) launched on ballistic missiles and air-breathing hypersonic cruise missiles (HCM) – represent a novel element in NATO's threat environment. Due to their combination of sustained rapid speed (at least Mach 5, or around 6,000 km/h), manoeuvrability, unpredictable flight paths, and other characteristics, hypersonic weaponry will intensify surprise, compress decision-making time, strain existing command-and-control structures, and alter warfighting and escalation dynamics.[1]

In coming years, NATO must craft an effective means of deterrence and defence against Russia's emerging arsenal of offensive hypersonic missiles

There are two general types of hypersonic delivery vehicles. Hypersonic glide (aka "boost-glide") vehicles are boosted into the upper atmosphere on ballistic missiles; then, at a predetermined height above 50 km in altitude, they detach from their rocket booster and glide unpowered towards a target, conducting evasive manoeuvres on the way down that make it more difficult to anticipate their targets or intercept the vehicles. In contrast, hypersonic cruise missiles, even if initially boosted by a plane or other vehicle, employ a rocket or, more commonly, ramjet or scramjet engine. These advanced engines, which lack moving parts, mix fuel with oxygen compressed from the surrounding air by the engine's own design to maintain sustained hypersonic propulsion. Due to their high speed, all hypersonic missiles offer defenders only a narrow time frame to respond. In coming years, NATO must craft an effective means of deterrence and defence against Russia's emerging arsenal of offensive hypersonic missiles.

The Russian Aerospace Forces are arming several types of fighters and bombers with precision-strike hypersonic systems

1. Russia's Hypersonic Portfolio

The Russian armed forces aim to equip several military branches with hypersonic delivery systems. The Russian Aerospace Forces are arming several types of fighters and bombers with precision-strike hypersonic systems. They have already developed the Kh-47M2 Kinzhal "Dagger" Air-Launched Ballistic Missile (ALBM); the Kh-47M2 can fly approximately 2,000 km with a maximum speed of Mach 10. It is presently deployed on a modified 1,000 km-range Mikoyan MiG-31K (NATO code name Foxhound) Soviet-era supersonic aircraft, which has a large payload and the power to carry the Kh-47M2 high into the atmosphere before releasing it for standoff strikes against land and sea targets. By 2024, the Russian military plans to base a fully operational MiG-31 Fighter Aviation Regiment at Kansk in Russia's Central Military District.[2] From this location, the planes can rapidly redeploy to Russia's upgraded Arctic bases and other regions.[3] In the future, the Russian Aerospace Forces may arm their strategic bombers with the Kh-47M2 or smaller versions of it. These may include the Tu-160 Blackjack supersonic bombers, which have a large payload and 15,000 km range, and the upgraded 2,000 km-range Tu-22M3 Backfire supersonic bombers, which can carry less but fly faster than the

[1] Margot van Loon, "Hypersonic Weapons: A Primer," in American Foreign Policy Council, *Defense Technology Program Brief*, no. 18 (May 2019), 3.

[2] Roger McDermott, "Russia's Aerospace Forces Prepare Training for Kinzhal Hypersonic Missiles," *Eurasia Daily Monitor*, May 13, 2020.

[3] "Russia's Su-57s Conducting Captive-Carry Tests of New Air-Launched Hypersonic Missile – Report," Sputnik, February 19, 2021.

Tu-160 Blackjack.[4] The new fifth-generation Su-57 Felon multirole stealth fighter-bomber has begun test flights with a new hypersonic missile.[5] Russia's new Tupolev PAK DA strategic bomber will also carry hypersonic missiles as part of its attack portfolio.[6] Although the PAK DA is not a supersonic bomber, the plane's missiles could hit targets in central and eastern Europe without leaving Russian air space. These Russian bomber and fighter forces will be complementary. While bombers have longer ranges and larger payloads, fighters generally have superior speed and manoeuvrability, allowing for tailored force packages for different scenarios.

The Russian Navy is equipping its cruisers, corvettes, and attack submarines with the new Tsirkon hypersonic missile, under development for the past decade

The Russian Navy has equipped its surface and subsurface vessels with a 3S-14 universal vertical launch system, which can fire multiple subsonic, supersonic, or hypersonic anti-ship and land-attack cruise missiles.[7] Russia has traditionally acquired long-range anti-ship missiles to compensate for its inferior numbers versus Western navies. Now the Russian Navy is equipping its cruisers, corvettes, and attack submarines with the new Tsirkon hypersonic missile, under development for the past decade.[8] It has undergone approximately a dozen operational tests, including against land and sea targets, launching from submarines and surface vessels, and in late December as a salvo shot involving a pair of missiles.[9] Alternatively spelled as Zircon, the Tsirkon (NATO code name SS-N-33) launches initially with a solid-propellant rocket booster and then relies on a scramjet air-breathing engine, and can fly twice as far and more than twice as fast as the current P-800 Onyx anti-ship missile.[10] Having a range of up to 1,000 km, the Tsirkon can attack both naval and land targets at speeds reportedly up to ten times the speed of sound (Mach 10).

In December 2021, Defence Minister Sergei Shoigu announced that the Tsirkon would enter into operational service with the Navy in the following year.[11] Though the multipurpose *Admiral Gorshkov*-class frigates will become the first Russian ship armed with the Tsirkon, according to the head of the United Shipbuilding Corporation, all future Russian warships can be equipped with it.[12] These could include *Kirov*-class battlecruisers, *Admiral Grigorovich*-class frigates, multiple classes of corvettes, and the next-generation *Yasen*-M class nuclear-powered attack submarines. The latter could prove particularly challenging for NATO defences since allied forces would not be able to know from where they might attack, further compounding the problem of tracking and intercepting hypersonic delivery systems. The Russian Navy even aims to equip many of its smaller vessels, such as coastal defence ships, with hypersonic missiles to give them long-range strike capacities.[13]

The Russian Navy even aims to equip many of its smaller vessels, such as coastal defence ships, with hypersonic missiles to give them long-range strike capacities

One major uncertainty is the extent to which Russian warships and other delivery platforms can take full advantage of hypersonic missiles given possible limits of the Russian detection, targeting, strike, and post-strike assessment kill chain.[14] Possible gaps may exit in Russia's global sensor coverage, long-range naval

4 Michael Peck, "Attention, Donald Trump: Russia's Tu-160 Bombers Are Getting Hypersonic Ballistic Missiles: Can America counter that?," *The National Interest*, February 15, 2020.

5 "First batch-produced Su-57 to be used for testing hypersonic weapons," TASS, December 25, 2020; and "Russia's Su-57s Conducting Captive-Carry Tests of New Air-Launched Hypersonic Missile – Report," Sputnik, February 19, 2021,.

6 "PAK DA demonstrational model to be ready by 2023 – source," TASS, August 1, 2021.

7 Steven Stashwick, "Russia Tests Anti-Ship Hypersonic Missile Against Sea Target," *The Diplomat*, October 8, 2020.

8 "Russia Stages First Ship-Launched 'Tsirkon' Hypersonic Missile Test," *The Moscow Times*, February 27, 2020.

9 "Putin Hails Multiple Launch Test of Hypersonic Missile," AFP, December 25, 2021,.

10 Franz-Stefan Gad, "Russia to Test Fire Tsirkon Hypersonic Missile From Yasen-Class Submarine," *The Diplomat*, March 12, 2020.

11 "Testing of Tsirkon missile about to end, supplies to begin 2022," TASS, December 21, 2021.

12 Kyle Mizokami, "Russia Just Tested Its Hypersonic Anti-Ship Missile," *Popular Mechanics*, March 1, 2020.

13 "Russia to modify its Tsirkon missiles for corvettes," *Navy Recognition*, January 23, 2019.

14 Joseph Henrotin, "Hypersonic Weapons: What Are the Challenges for the Armed Forces?," Institut Francais des Relations Internationals, June 18, 2021.

reconnaissance, and other elements of Russia's Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) capabilities. Towards this end, the Russian armed forces have been testing a new naval automated control system closely integrated with the Tsirkon.[15] The Navy could also equip some missiles with nuclear warheads to help compensate for targeting and navigation uncertainties since a nuclear detonation would destroy a vessel even if its delivery system was somewhat off target.[16]

A recent exercise shows how the Russian armed forces might integrate these capabilities in combat. At the end of June 2021, the Russian Navy and Aerospace Forces conducted a combined drill off the coast of Syria in the eastern Mediterranean. According to a statement released by the Russian Ministry of Defence, "In the course of the joint manoeuvres of the Russian Navy's standing Mediterranean taskforce and aircraft of Russia's Aerospace Force that kicked off in the eastern Mediterranean on June 25, the crews of MiG-31K planes capable of employing the latest Kinzhal hypersonic missiles that arrived at the Russian Hmeimim airbase in the Syrian Arab Republic the other day have started accomplishing the tasks of mastering the airspace in the maritime zone."[17] The Russian military released a video showing a Mig-31 taking off from the base with the Kinzhal. In addition to the MiG-31Ks, the planes that participated in the Syrian drills included Tu-142MK and Il-38 maritime reconnaissance and anti-submarine warfare aircraft, as well as several Tu-22M3 strategic bombers and Su-35S air superiority planes. The warships participating in the exercises included the *Admiral Essen* and *Admiral Makarov* frigates, the *Moskva* missile cruiser, and the *Stary Oskol* and *Rostov-on-Don* Kilo-class diesel-electric submarines.[18] Such a combined force could jointly strike coastal targets or naval targets, with the Mig-31Ks using Kinzhals to remove high-value targets such as adversarial air-and-missile defence systems and aircraft carriers. (The planes reportedly simulated attacks against the Royal Navy's only carrier, the *HMS Queen Elizabeth,* which at the time was conducting air strikes against ISIS targets in Iraq and Syria while on patrol in the eastern Mediterranean).[19]

Moreover, despite Russian leaders' recurring denunciations of NATO missile defence efforts, the Russian Federation is the only country that has an active programme to develop near-term national defences against hypersonic missiles. Putin has declared the goal of having an operational national hypersonic missile defence system by the time the United States deploys such weapons. The latest versions of Russia's early-warning radars, the Rezonans-N systems, have been designed to detect incoming hypersonic missiles.[20] In a March 2020 test, a S-400 Triumf surface-to-air missile defence system reportedly demonstrated a capacity to intercept hypersonic targets.[21] The most advanced Russian air-and-missile defence systems, the S-500 Prometheus (aka 55R6M Triumfator-M) and the newly announced S-550, which are now entering into service, have a declared ability to intercept hypersonic targets in near-Earth space.[22]

The Russian Federation is the only country that has an active programme to develop near-term national defences against hypersonic missiles

China has also been researching, developing, and deploying a range of hypersonic delivery systems. In accordance with the PRC's military-civil fusion approach, this comprehensive R&D effort encompasses academic, commercial, scientific, and military projects. Before 2017, most Chinese HGV tests involved shorter-range ballistic missiles, which would be optimal for

[15] Roger McDermott, "Russia's Northern Fleet Integrates Automated C2 and Hypersonic Strike," *Eurasia Daily Monitor*, September 8, 2021.

[16] Pavel Felgenhauer, "The Hypersonic Hype and Russia's Diminished Nuclear Threshold," *Eurasia Daily Monitor*, August 6, 2020.

[17] "MiG-31K fighters join Russian Navy's maneuvers in Mediterranean," TASS, June 25, 2021.

[18] *Ibid.*

[19] Peter Suciu, "Russia's Military Is Out to Prove it Can Use Hypersonic Weapons in a War," 1945, June 26, 2021.

[20] "Источник: Россия развернет на Кольском полуострове двух «охотников за гиперзвуком" [Source: Russia will deploy two "hunters of hypersonics" in the Kola peninsula]," TASS, February 6, 2020.

[21] "S-400 Anti-Aircraft Missile Systems Strike Hypersonic Targets in Eastern Siberia Drills," TASS, March 27, 2020.

[22] "Russia Touts S-500's Ability to Destroy Hypersonic Weapons in Space," *The Moscow Times*, July 3, 2020; and "First S-550 air defense systems enter service in Russia – source," TASS, December 29, 2021.

strikes against Taiwan, Japan, or US bases in the western Pacific. In the fall of 2019, China unveiled the DF-17, an intermediate-range ballistic missile specifically designed to launch the DF-ZF HGV to hit more distant targets to a distance of some 2,500 km.[23] Last summer, China reportedly tested a fractional orbital bombardment system, which could launch a HGV into space and then deorbit it over a particular position on Earth, essentially allowing China to attack many targets in the North Atlantic region which are within NATO's area of responsibility under Article 6 of the North Atlantic Treaty.[24]

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2. Implications for NATO

Shoigu has said that Moscow's diverse portfolio of hypersonic weapons will form "the backbone of Russia's non-nuclear deterrence forces."[25] Though it will take years for Russia to field many hypersonic delivery systems, even a few hypersonic weapons, of varying speeds and ranges, will substantially complicate NATO defences. Russia is pursuing hypersonic capabilities to defeat alliance forces in wartime; deter attacks on Russian national territory; discourage NATO military intervention in neighbouring countries that Moscow sees as falling within Russia's regional spheres of influence; challenge the credibility of US security guarantees to NATO allies; hold critical defence and dual-use infrastructure and military forces at risk; and provide additional means of coercing NATO allies and partners in peacetime. Since hypersonic systems pose a different threat profile than Russia's other systems, they can hold NATO assets at risk in novel or different ways, which could change when and how Russia may launch strikes against targets. They also raise the risks of crises, wars, and escalation by potentially making Russian decision makers more confident about employing force, controlling conflicts, making rapid war gains, and deterring or defeating NATO counteractions.

Since hypersonic systems pose a different threat profile than Russia's other systems, they can hold NATO assets at risk in novel or different ways

2.1. Soviet Origins

Russia's poor military performance against Georgia in August 2008 spurred a comprehensive military reform that streamlined command layers, reduced officer corps billets, and decreased reliance on conscript soldiers, and transitioned the Soviet-era mass mobilisation army to a smaller, more professional, battle-ready force. The Russian government also launched a programme to revitalise the country's military-industrial complex by: enhancing Russia's research, development, testing and evaluation (RDT&E) infrastructure; forging novel public-private innovation partnerships, including the establishment of high-tech defence industrial parks and strengthening ties between academic, research, and the defence-industrial institutions; launching a new National Defence Management Centre for processing real-time data; initiating a Russian Foundation for Advanced Research Projects to support, like the US Defense Advanced Research Projects Agency, high-risk but potentially high-payoff defence technologies; decreasing parliamentary, media, and other civilian oversights of Russia's military technology activities; and increasing defence R&D expenditures. The reforms have also refocused the national defence establishment on exploiting what Marshal Nikolai Ogarkov, Chief of the Soviet General Staff from 1977-1984, termed the Military-Technical Revolution. Impressed by the increasing precision of high-tech weaponry, Ogarkov's vision was to combine emerging strike systems and novel information

[23] Yang Sheng and Liu Xuanzun, "DF-17 ballistic missile makes debut at National Day parade," *Global Times*, October 1, 2019.

[24] Shannon Bugos, "China Tested Hypersonic Capability," *Arms Control Today*, November 2021.

[25] "Hypersonic weapons to comprise backbone of Russia's conventional deterrence forces," TASS, February 9, 2021.

technologies with Russia's long-standing strengths in mass and firepower. The intent was to attain sustainable advantages through early gains at the initial stages of conflict. The expectation was that, through these qualitative enhancements, Russian forces would make rapid gains and then thwart adversary countermeasures by, for instance, building layered and interlinked Anti-Access/Area Denial (A2/AD) bubbles. As a result, Russia would win the battle of attrition and resolve, terminating the war on favourable terms.

Russian decision makers now believe that exploiting advanced hypersonic technologies will empower the Russian armed forces to compete better with NATO militaries in critical domains

2.2. Tasks and Missions

Russian decision makers now believe that exploiting advanced hypersonic technologies will empower the Russian armed forces to compete better with NATO militaries in critical domains. Russia has been seeking both a limited number of Avangard strategic nuclear HGVs and several types of operational-tactical systems. The Avangard is designed primarily for assured strategic retaliation against the US homeland; the non-strategic systems are intended for operational strikes against NATO's forward-deployed forces. Regarding the former, Russian policymakers have diversified beyond traditional intercontinental ballistic missiles (ICBM) as a hedge against improving US deterrence by denial capabilities. They want an assured retaliatory second-strike capability against whatever US homeland advancements the United States makes in missile defence technologies. Moscow seeks this capacity for both offensive and defensive purposes. In line with Moscow's theory of military victory, Russia's hypersonic and other strike systems aim to deter US assistance to NATO countries by providing enhanced means to attack the US homeland. Similarly, their augmented force could make threats of retaliation to NATO attacks against Russian territory more credible.

At the operational level, Russian policymakers expect hypersonic technologies to bolster Russia's power projection, non-strategic nuclear options, and "active defence" capabilities.

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Russian military planners perceive hypersonic capabilities as asymmetric instruments to negate NATO military advantages by destroying the alliance's critical military infrastructure, missile defences, command-and-control centres, air and sea bases, logistical hubs, forward-operating forces, and other high-value targets. In particular, Moscow envisions hypersonic technologies as means to revitalise many of the Soviet-era warplanes and warships that will remain in service as well as to enhance any new platforms that Moscow can produce.[26] Given the difficulties the Russian military-industrial complex has faced in producing novel platforms, renewing existing planes and ships with modern missiles and other technologies provides a means to sustain Russian military power during the transition to a wholly post-Soviet force.

Russia could use its hypersonic missiles as first-strike weapons, employed in conjunction with large-scale cyber and electronic warfare, to blind and paralyse NATO defenders

Even limited range hypersonic delivery systems can have strategic effects. Russia could use its hypersonic missiles as first-strike weapons, employed in conjunction with large-scale cyber and electronic warfare, to blind and paralyse NATO defenders. They give defenders less time to respond, an advantage when attacking time-sensitive, mobile, or high-value targets. Conversely, Russia can employ hypersonic missiles as formidable first-strike weapons for disabling NATO's air-and-missile defences, thereby facilitating follow-on strikes by Russia's non-hypersonic delivery systems. In addition to counterforce strikes against NATO weapon

[26] Theresa Hitchens, "B-52 Could Get New Hypersonic Missile: Global Strike Commander," *Breaking Defense*, February 25, 2021.

systems, hypersonic strike systems can degrade NATO's command, control, and transportation facilities, compromising the alliance's ability to rely on member countries' ports, airfields, and other infrastructure. Even a successful intercept with a point defence system might not shield the target since the missile's debris would rain on it at hypersonic speeds. Furthermore, though Russian representatives deny that they have an "escalate-to-deescalate" doctrine to employ nuclear munitions to shock NATO into backing down in a conflict, nuclear-armed hypersonic weapons could provide another means for Moscow to exploit Western fears of Russian escalation from conventional to nuclear warfare in a war. For example, Moscow might launch a nuclear-capable hypersonic missile during a conventional conflict in Europe to highlight the dangers of escalation to nuclear weapons' use. The threat to NATO from Russian hypersonic strike systems results from both the damage they can inflict through direct attacks and the increased risks of escalation they pose in limited nuclear or major conventional conflicts in Europe.

Moscow's hypersonic anti-ship, anti-air and ground-to-ground missiles can decrease NATO power projection capabilities by augmenting Russia's A2/AD capabilities along Russia's periphery. Their manoeuvrability, speed, and target ambiguity can complicate efforts to track and intercept them, especially as they fly below the targeting range of most ground-based missile radars, which are typically looking at higher attitudes, and associated endo-atmospheric ballistic missile defence (BMD) interceptors but above the range of lower-level radars and interceptors like the Patriot. In this manner, they can elude the widely available NATO sensors designed to take custody of incoming missiles and generate an equation to intercept them. Their wing design allows for greater lateral and vertical manoeuvres than traditional missiles flying more parabolic paths. Their high speed would also confront NATO with a compressed response time compared with the opportunities to defend against slower flying non-hypersonic missiles or planes. All these characteristics give hypersonic delivery systems an advantage for hitting time-sensitive, mobile, or high-value targets. Moscow's hypersonic capabilities thereby reinforce its capacity to challenge NATO's ability to deploy and operate forces in Russia's vicinity. These hypersonic delivery systems, combined with Russia's other offensive strike systems, could help Moscow negate NATO's integrated multi-domain operations.[27]

Hypersonic delivery systems, combined with Russia's other offensive strike systems, could help Moscow negate NATO's integrated multi-domain operations

The characteristics of Russia's emerging hypersonic delivery systems could worsen strategic stability – the lack of incentive to launch wars – by potentially making Russian decision makers more confident about successfully employing force, making rapid military gains, and deterring or defeating NATO counteractions. They could thereby raise the risks of regional crises and wars as well as weaken the credibility of allied conventional deterrence. Furthermore, hypersonic capabilities can challenge crisis stability – defined as a condition when parties lack the incentive to attack first in a crisis – by giving possessors reasons to strike first in a potential conflict. Given the contemporary limits of sensor and interceptor technologies, NATO countries can at best detect the launch of a Russian HGV, but then lose track of the missile until it has impacted its target.

Russia would likely employ hypersonic systems early in a conflict to disable high-priority NATO defence structures

Due to their special characteristics of speed and manoeuvrability, as well as their probably limited availability in a conflict due to their high costs, Russia would likely employ hypersonic systems early in a conflict to disable high-priority NATO defence structures. In particular, Russia could employ these systems as pre-emptive weapons to decapitate NATO's command, control, and communications networks, denying fielded forces access to the enabling networks to which they have become accustomed and impeding their ability from acting as a coherent entity. If they disabled critical NATO defence systems (such as the alliance's forward-based integrated

[27] "Russia Floats Pre-Emptive 'Intimidation' Strike to Counter U.S. Strategy," *The Moscow Times*, February 9, 2021.

air-and-missile defences) early in a conflict, they would make it easier for Russia's non-hypersonic systems to overcome other NATO defences. Conversely, due to their currently limited number and vulnerability before they launch, Russia's hypersonic systems are themselves valuable targets for NATO first strikes. Thus, Russian policymakers have an incentive to use them early in a conflict before they lose them.

Even in the absence of a war, hypersonic capabilities provide Russia with additional means for peacetime coercion of US allies and other countries to realign their policies in line with Moscow's preferences. Russian policymakers could leverage the elevated risk of escalation provided by hypersonic weapons to provide a shield under which Russia could intensify its hybrid, grey-zone intimidation and subversion.

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Moscow can brandish hypersonic missiles to discourage NATO countries from hosting US forces or specific weapons systems, such as missile defences. For example, Kremlin presidential spokesperson Dmitry Peskov said that one reason Russia had tested a salvo of its Tsirkon hypersonic missiles on 24 December was to make its demands for a new European security treaty "more convincing".[28]

3. How to Respond

NATO can employ a combination of deterrence, defence, and arms control measures to address the novel challenges associated with Russia's growing arsenal of offensive hypersonic missiles.

3.1. Defence and Deterrence

In response to the growing extant threat from Russia's hypersonic missiles, as well as the potential emerging threat from China's hypersonic development programmes, NATO countries will need to upgrade their radar and other sensor coverage to detect the trajectories of hypersonic missiles after launch. The alliance will also need superior early-warning and command-and-control systems to make more rapid threat assessments and responses to these hypersonic missile launches.

NATO countries will need to upgrade their radar and other sensor coverage to detect the trajectories of hypersonic missiles after launch. The alliance will also need superior early-warning and command-and-control systems

NATO countries should also conduct more exercises simulating defending against Russia's hypersonic missiles. To decrease NATO forces' vulnerability to Russia's hypersonic delivery systems, NATO commanders can increase their use of passive measures such as concealment, hardening, dispersal, deception, mobility, redundancy, and enhancing reconstitution capabilities. Since Russia could employ its hypersonic weapons to decapitate NATO's C4ISR systems, they could prevent NATO forces from acting as a coherent entity. NATO forces will need to prepare to operate in scenarios even after they suffer tactical decapitation of critical C4ISR nodes due to Russian hypersonic, cyber, and other attacks. NATO forces need to plan and train a force to potentially operate without the superior C4ISR structure that the United States and its allies have enjoyed for decades – operating for a period of time without connecting with robust network of sensors and commend elements.

More active defences against Russian hypersonic delivery systems might include disrupting their targeting data or communications, investing in novel BMD technologies, and building a network of space-based sensors to provide "birth-to-death" tracking of objects in the upper atmosphere. Moreover, NATO members could enhance their export controls to deny Russian entities' access to Western military and dual-use goods and technologies that could contribute to the Russian military's hypersonic capabilities.

[28] Jamie Dettmer, "Russia Lays Down More Conditions for Peace Talks," VOA News, December 27, 2021.

China's hypersonic programme has benefitted from such imported Western technologies.[29]

More active defences against Russian hypersonic delivery systems might include disrupting their targeting data or communications, investing in novel BMD technologies, and building a network of space-based sensors

Furthermore, NATO governments should cooperate to restrict the flow of technologies, equipment, and material that Russia, China, and other potential adversaries could use to augment their hypersonic capabilities. Additionally, NATO will need to evaluate the effects of any allied and partner military interoperability gaps due to the likely more rapid US acquisition of hypersonic defence technologies than other Western countries. NATO governments require "interlocking" air and missile defence systems, with integrated command-and-control supported by interoperable or at least complementary capabilities, to establish comprehensive shields against hypersonic missiles.[30]

NATO governments should cooperate to restrict the flow of technologies, equipment, and material that Russia, China, and other potential adversaries could use to augment their hypersonic capabilities

Russia's and China's progress in developing hypersonic missiles has contributed to the decision of NATO countries to pursue similar capabilities. One multinational project under the auspices of the EU's Permanent Structured Cooperation (PESCO) aims to field a Mach 5-speed missile interceptor by around 2030 as part of a larger effort to enhance the EU's capacity for employing space-based surveillance to counter missile threats.[31] The thinking is that a scramjet hypersonic interceptor could have greater range, speed and energy upon impact.[32]

A joint French-British project to develop a Future Cruise/Anti-Ship Weapon (FC/ASW) has fallen into abeyance due to the AUKUS dispute.[33] France is independently researching a potential scramjet-powered nuclear-armed missile for possible development on strategic bombers in the mid-2030s and funding a HGV demonstration project, the Vehicule Manoeuvrant Experimental (V-MaX).[34] The United States is pursuing several hypersonic R&D programmes that are at various stages of execution but, unlike Russia and China, the United States has yet to deploy an operational hypersonic capability. For example, the US Army Artillery Regiment, 17th Field Artillery Brigade, is experimenting with a manoeuvrable ground-launched Long-Range Hypersonic Weapon in order to develop appropriate doctrine, tactics, techniques and procedures for its use.[35] Though it is well-funded, the US hypersonic test programme, perhaps due to its rushed nature, has suffered several mishaps.[36] In contrast to Russia and China, which have tested strategic HGVs designed to overcome US homeland missile defences, NATO militaries are seeking offensive hypersonic missiles exclusively for conventional counterforce strikes against high-value military targets. They can provide a niche capability for a limited range of scenarios to supplement NATO's more numerous theatre-range attack aircraft and non-hypersonic missiles.

NATO militaries are seeking offensive hypersonic missiles exclusively for conventional counterforce strikes against high-value military targets

[29] Ellen Nakashima and Gerry Shih, "China builds advanced weapons systems using American chip technology," *The Washington Post*, April 7, 2021.

[30] Vivienne Machi, "Where does NATO fit into the global hypersonic contest?," *Defense News*, March 15, 2021.

[31] Sebastian Sprenger, "Germany joins nascent European push to shoot down hypersonic missiles," *Defense News,* November 30, 2020.

[32] Tony Osborne, "European States Plan For Hypersonic Defense," *Aviation Week*, January 10, 2020.

[33] Andrew Chuter, "Decisions on new British-French cruise missile are left hanging after submarine row," *Defense News*, September 21, 2021.

[34] "International Hypersonic Strike Weapons Projects Accelerate," Security & Defense Portal of Québec, June 15, 2020; and Clement Charpentreau, "France to test V-MAX hypersonic glider in coming months," Aerotime Hub, May 12, 2021.

[35] "Army delivers first hypersonics ground equipment," U.S. Army Rapid Capabilities and Critical Technologies Office, October 7, 2021.

[36] Joshua Pollack, "Why Do US Hypersonic Missile Tests Keep Failing? They're Going Too Fast," January 3, 2022.

General John Hyten, Vice Chairman of the Joint Chiefs of Staff, said that US hypersonic systems could attack "distant, defended, and/or time-critical threats when other [US] forces are unavailable, denied access, or not preferred."[37] NATO hypersonic missiles could enhance deterrence of Russian policymakers, reassure NATO members and partners threatened by Russia, and counter perceptions of a "hypersonic gap" with Moscow. Hypersonic systems could help NATO penetrate Russia's formidable A2/AD bubbles since these high-speed delivery vehicles could launch further away from Russian defences but still rapidly reach their targets, which could include the A2/AD defensive systems or the objects they are trying to protect. They could also more effectively reach road- or rail-mobile missiles (if they can be detected), along with ships and planes, before they move far. NATO might employ hypersonic delivery systems pre-emptively to destroy Russian hypersonic weapons before Moscow launches them rather than avoid reliance on expensive and only partially effective defences.

Still, NATO hypersonic strikes against Russian targets could generate escalation dynamics due to their potential to degrade Russia's nuclear deterrent, encouraging Moscow to launch the very pre-emptive attacks that NATO hopes to deter. Furthermore, while NATO has stated that, "Russia's new hypersonic missiles are highly destabilising and pose significant risks to security and stability across the Euro-Atlantic area", the allied governments have affirmed that they would "respond in measured way" and not necessarily "mirror what Russia does, but we will maintain credible deterrence and defence, to protect our nations."[38] Most likely, NATO countries will rely on a combination of deterring strategic attacks through a threat of retaliation and thwarting Russian hypersonic counterforce strikes though passive and active defences and limited offensive strikes at hypersonic launching platforms on Russian warships and warplanes.

NATO hypersonic strikes against Russian targets could generate escalation dynamics due to their potential to degrade Russia's nuclear deterrent, encouraging Moscow to launch the very preemptive attacks that NATO hopes to deter

3.2. Arms Control Options

At least some NATO offensive hypersonic capabilities, might prove valuable for generating arms control leverage with Moscow.

Russian policymakers might be willing to accept limits on Russian hypersonic capabilities to prevent NATO hypersonic missiles from substantially devaluing their integrated air-and-missile defences

Despite the collapse of the Intermediate-Range Nuclear Forces (INF) Treaty, the Conventional Forces in Europe Treaty, and the Open Skies Treaty, Russia's recently published draft European security treaties underscore Moscow's interest in constraining NATO's capacity to attack Russian targets. Russian policymakers might be willing to accept limits on Russian hypersonic capabilities to prevent NATO hypersonic missiles from substantially devaluing their integrated air-and-missile defences. Although any hypersonic systems would be nationally acquired and managed, NATO mechanisms can assist with keeping all allies informed of each other's national programmes as well as support combined alliance planning, pooling R&D insights, and coordinating export controls of hypersonic-relevant technologies. Yet, NATO decision makers would need to balance the gains from bolstering its offensive hypersonic capabilities with the potential costs, such as worsening crisis stability and escalation dynamics if Russian leaders, fearing NATO pre-emption, conclude they must employ their hypersonic strike systems early in a crisis to avoid losing them.

[37] "Testimony of John E. Hyten," Hearing on United States Strategic Command and United States Northern Command, Senate Committee on Armed Services, U.S. Congress, February 26, 2019.

[38] Dave Makichuk, "Russia's 'invincible' Zircon missile hits test target," *Asia Times*, July 20, 2021.

Though New START imposes some limits on Russia's strategic hypersonic delivery systems, since the demise of the INF Treaty in August 2019, no arms control agreements presently constrict Russia's non-strategic delivery systems. Even so, constraining addition Russian hypersonic capabilities through arms control agreements might be possible. Russian Foreign Minister Sergey Lavrov and Deputy Foreign Minister Sergey Ryabkov have affirmed Moscow's interest in discussing hypersonic weapons with the United States through their strategic stability dialogue.[39] NATO governments would need to decide whether to propose limiting other weapons systems at the same time, what ceilings and counting rules to apply to these systems, and how to verify compliance with any agreement. Any agreed limits could apply to specific types of hypersonic missiles, such as those of a certain range, or those launched from specific parts of Earth (from the ground, air, or sea), or having varying types of warheads (namely, conventional or nuclear). Allies will need to assess the net costs and benefits of limiting NATO capabilities in exchange for constraining Russian hypersonic systems. A similar trade-off would arise in weighing the relative importance of protecting US offensive hypersonic options to deter Russia, versus reassuring Moscow that the alliance is not pursuing a first-strike capacity against them by constraining NATO's offensive systems. For instance, some partial ceilings (for numbers, types, capabilities, or locations) could reduce fears of a disarming first strike. Given China's growing hypersonic reach, NATO governments would also need to decide to what extent they would require any limitation agreements to cover China's hypersonic systems as well as those of Russia.

Allies will need to assess the net costs and benefits of limiting NATO capabilities in exchange for constraining Russian hypersonic systems

Any arms accord with Russia may have to cover more than hypersonic weaponry. Moscow would likely demand restraints beyond NATO's own hypersonic strike systems. For example, Russian policymakers justify their interest in hypersonic systems as a means to overcome Western missile defences. Peskov said that Russia's hypersonic missile programmes were a response to NATO BMD deployments near Russia, and other Western actions that had allegedly undermined strategic stability in Europe weakened Russian security.[40]

The alliance must be wary of Moscow's efforts to constrain NATO capabilities in unbalanced ways

If NATO members pursue only conventionally armed hypersonic delivery systems, allied negotiators might propose prohibiting all nuclear-armed hypersonic missiles. The alliance must be wary of Moscow's efforts to constrain NATO capabilities in unbalanced ways. For example, Russia would likely propose a blanket prohibition on the deployment of land-based hypersonic delivery systems outside of national territories, effectively constraining US but not Russian capabilities stationed in Europe. Article 7 of its draft Russian-US European security treaty reads: "The Parties shall refrain from deploying nuclear weapons outside their national territories and return such weapons that have already been deployed outside their national territories at the time of the entry into force of the present Treaty to their national territories."[41] It is not hard to imagine Moscow proposing similar language for hypersonic and other delivery systems.

In addition to exploring ceilings on the numbers, types, capabilities, or locations of certain hypersonic weapons, NATO and Russia could pursue select transparency and confidence-building measures

[39] "Russia invites US to discuss all strategic stability issues – Lavrov," TASS, February 19, 2021; "Moscow Not Excluding Dialogue with US on Russia's Latest Weapons Systems," Sputnik, July 6, 2021.

[40] "Russia's hypersonic missiles are response to US missile shield near its borders – Kremlin," TASS, July 20, 2021.

[41] "Договор между Российской Федерацией и Соединенными Штатами Америки о гарантиях безопасности [Treaty between the Russian Federation and the United States of America on the security guarantees]" Russian Ministry of Foreign Affairs, December 17, 2021.

In addition to exploring ceilings on the numbers, types, capabilities, or locations of certain hypersonic weapons, NATO and Russia could pursue select transparency and confidence-building measures (TCBMs) aimed to decrease risks of miscalculation, remove first strike vulnerabilities, and take other steps to decrease escalation risks. TCBMs might encompass sharing information on capabilities of planned hypersonic weapons. Data exchanges could encompass the types of hypersonic weapons that Russia and NATO are pursuing, the timeline and general magnitude of their programmes, and the doctrines governing their potential employment. In February 2021, Anatoly Antonov, the Russian Ambassador to the United States, stated that his government was interested in discussing new military technologies and other factors affecting the "security equation" between Russia and the United States.[42] Russia and NATO members could also notify other parties in advance before test launching hypersonic missiles to avoid misunderstanding. Attaining such operational arms control to decrease the risks of accidental or inadvertent wars might be easier than negotiating and ratifying new treaties. TCBMs could be adopted through less formal agreements. Furthermore, NATO-Russian dialogue is needed to clarify what systems could qualify as "hypersonic" under arms control agreements. Many delivery vehicles commonly termed "hypersonic" do not fly above Mach 5 for their entire flight. Meanwhile, ICBMs and submarine-launched ballistic missiles (SLBM) fly faster than Mach 5 for much of their trajectories. This definitional ambiguity may increase as Russia and NATO develop additional types of delivery vehicles and launching platforms, some mobile and dual-capable, to complicate adversary defences.

Perhaps the most promising area for arms control would involve NATO-Russian cooperation to limit the proliferation of hypersonic weapons to certain other states. For example, the Missile Technology Control Regime, of which Russia is a member, might provide a mechanism to restrict the transfer of equipment, material, and technologies that could contribute to other countries' hypersonic missiles. Such coordination would also extend to help keep sensitive hypersonic technologies away from non-state actors such as terrorist groups and transnational criminal organisations that might sell them to others.

Conclusion

The implications of hypersonic weapons for NATO security will change over time. For the next few years, they will primarily serve as niche weapons employed for special missions. But as their technologies improve and costs of production decline, they could become a more important factor for many more defence scenarios. Additionally, hypersonic systems are not arriving in isolation. Their impact will be amplified by other developments, such as improvements in information processing, space sensors and counterspace weapons, and cyber capabilities. Monitoring the development of these technologies and how they are being incorporated into the doctrine of Russia and other countries will be essential for assessing how (and how much) they will disrupt existing concepts. In the absence of wartime experience, constant wargaming, exercises, and experimentation will also help assess the potential combined effect of these developments, helping answer the key question whether their impact will be as great as the advent of stealth technologies or missiles with multiple independently targetable re-entry vehicles – or whether they will simply aggravate an already worsening NATO threat environment.[43]

Hypersonic systems are not arriving in isolation. Their impact will be amplified by other developments, such as improvements in information processing, space sensors and counterspace weapons, and cyber capabilities

[42] "Russia stays ready for talks with US on new military technology – ambassador," TASS, February 19, 2021.

[43] Bruce M. Sugden, "Analyzing the Potential Disruptive Effects of Hypersonic Missiles on Strategy and Joint Warfighting," *Joint Force Quarterly*, December 29, 2021.

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63/4 Narva Rd., 10120 Tallinn, Estonia
info@icds.ee

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