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Contextualizing Russia's Hypersonic Threat: Perceptions, Motivations, and Strategic Stability.

Jeffery D. Taylor
Utah State University, jeffrey.taylor@edu.edu

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Rather than specific military objectives in Europe, Russian hypersonic missile development manifests deep-rooted perceptions of the United States and NATO undermining strategic stability through missile defense.

Russia appears to be leading the world in the development and deployment of hypersonic weapons – maneuverable weapons that can travel at speeds over five times the speed of sound – which raises concerns among U.S. policymakers about Russia's capabilities and intentions in an age of great power competition.[*] Development in hypersonic weapons dates back to the Cold War, when both the United States and USSR had several hypersonic programs. However, only recently have hypersonic weapons become viable, thanks to breakthroughs in fundamental hypersonic research. Currently, the United States, Russia, and China are all advancing hypersonic research and development, creating a competitive environment that many analysts have characterized as an arms race.

To date, the U.S. response to this arms-race dynamic, and Russia's leading position in it, has been primarily focused on achieving and maintaining technological overmatch – or technological superiority – in hypersonic technology. However, as U.S. policy makers develop and implement ongoing programs related to hypersonics, it will be critical to consider how well these policies address the fundamental drivers of Russian hypersonic development and how they are likely to affect Russian hypersonic development moving forward. In order to do this, it is important that policy makers understand how Russia perceives threats from the United States and NATO and Russia's motivations for pursuing hypersonic weapons.

This paper reviews potential mechanisms by which hypersonic weapons may challenge strategic stability from a deterrence – both nuclear and conventional – and arms-control perspective and briefly reviews the global state of play of hypersonic development. The paper then narrows on Russia's hypersonic capabilities and provides an analysis of possible threat perceptions, motivations, and intentions that may be driving Russian hypersonic weapons development. Finally, the paper critiques current U.S. policy toward Russia's ongoing hypersonic weapons development and presents several forward-looking considerations for a comprehensive U.S. response aiming toward greater strategic stability.

Hypersonic Evolution: High-Speed Maneuverability

Recent advances in hypersonic technology push the limits of speed and maneuverability on the spectrum of existing missile system capabilities.[1] In the most general sense, the term hypersonic can be used to identify any vehicle that travels at or greater than Mach 5, or five times the speed of sound, including traditional intercontinental ballistic missiles (ICBM), which can travel well above Mach 20 at final reentry phases.[2] However, in the national security and defense communities, the term hypersonic is used almost exclusively to identify weapons systems that couple hypersonic speed with significant aerodynamic maneuverability. This paper uses the same naming convention.

Within the hypersonic subset of missile systems, there are two main categories: hypersonic glide vehicles (HGV) and hypersonic cruise missiles (HCM). Hypersonic glide vehicles, or boost-glide vehicles, are usually carried on ballistic missile boosters to around 100 km altitude, where they detach and maneuver through the upper atmosphere, usually unpowered, at speeds that can exceed Mach 20.[3] An HGV may have a range of over 6,000 km. Hypersonic cruise missiles are generally powered by a ramjet or scramjet (supersonic combustion ramjet) engine and typically operate between Mach 5 and Mach 10, with a range of between 500-1,000 km. Scramjet engines can only operate at supersonic speeds. Therefore, HCMs must be accelerated to high speeds before operation, which is typically done by an aircraft, a first-stage booster, or a combination of both. Using small boosters, an HCM can be air, sea, or land launched.

Several foreign countries have begun deployment of select hypersonic systems, but significant technical barriers remain that may limit the performance of current hypersonic weapons. For instance, during hypersonic flight, the air around a vehicle superheats and becomes ionized, creating a sheath around the vehicle. This superheated air can cause significant vehicle deformations, which hurt aerodynamic performance and maneuverability, and in extreme cases it can cause structural failure. The ionized sheath also creates a barrier for secure in-flight communication with the vehicle and creates challenges for sustained air-breathing propulsion. Overcoming these challenges requires the use of advanced materials, which are generally very expensive and require advanced manufacturing methods. This and other elements of hypersonic vehicle design greatly increase the development and production costs of hypersonic weapons. Due to these development challenges and production costs, large-scale deployment of hypersonic systems will likely not occur for some time. Nevertheless, ongoing foreign hypersonic development and limited deployment of foreign hypersonic systems, especially by the Russian Federation, have immediate implications on U.S. national security.

Potential Consequences of Hypersonic Weapons Technology

A comprehensive threat analysis regarding hypersonic weapons and their full strategic consequences is a complex topic that involves many facets and is beyond the scope of this paper. Instead, this paper considers key consequences of hypersonic weapons technology for U.S. national security. Those considered here fall mainly into three categories, which are often highly interrelated: technical consequences directly related to evolutionary hypersonic capabilities, strategic consequences resulting from the use of hypersonic weapons in deterrence roles, and consequences of hypersonic weapons development for strategic stability.

1. Technical Consequences

The technical advantages of hypersonic weapons center around their speed, range, and maneuverability, which complicate existing missile defense. The hypersonic advantage is typically framed in terms of a comparison of hypersonic weapons to traditional ballistic missiles. Whereas traditional ballistic missiles follow a predictable trajectory that can reach altitudes of over 1,000-2,000 km,[4] HGVs travel along unpredictable trajectories at nearly one-tenth this altitude, and HCMs can maneuver at very low altitude. Currently fielded U.S. missile-defense systems are primarily tailored to detect and target ballistic missiles using ground-based RADAR – augmented by a very small number of space-based sensors – and counter missiles during the high-altitude midcourse or relatively predictable terminal phase of a ballistic trajectory using ground- and sea-based interceptors.[5] The relatively low operating altitude and high maneuverability of hypersonic weapons in their midcourse and terminal phases make them less vulnerable to detection by ground-based RADAR sensors than ballistic missiles,[6] and once detected, they are difficult to counter with systems designed to intercept ballistic missiles. Thus, a hypersonic weapon has a much higher chance than a ballistic missile to bypass missile defense.

In addition to the threat this poses to U.S. territory and installations, this capability could also be leveraged to enhance anti-access/area denial (A2/AD) capabilities in conventional conflict.[7] For example, China and Russia have advertised hypersonic systems as effective platforms for launching A2/AD strikes against U.S. carrier groups in the Indo-Pacific and the Mediterranean from outside the range of typical air defenses.[8] Utilizing hypersonic weapons in this way could prevent the United States from effectively responding to an attempt by Russia or China to assert authority by force along their periphery, perhaps in Taiwan or the Baltics. It could also put U.S. military facilities and personnel in Europe or East Asia at risk of rapid surprise attacks in the event of a military conflict in Eastern Europe or the Taiwan Strait.

While hypersonic weapons have a marked advantage over traditional ballistic

missiles in defeating missile defenses, limiting the discussion of hypersonic weapon performance to this comparison often creates a false perception that hypersonic weapons are revolutionary. In fact, the vast majority of missile systems currently deployed by the United States and its foreign adversaries are technically non-ballistic and have capabilities, including maneuverability, decoys, and chaff, that pose a significant challenge for existing missile-defense systems.[9] Moreover, both China and Russia have a sufficient number of strategic nuclear warheads to overwhelm U.S. missile defense with a large salvo.[10] Therefore, many analysts argue that hypersonic weapons do not significantly alter the missile threat status quo.[11] It appears, though, that this view is not shared by foreign policymakers and military officials who continue to invest in the development of hypersonic weapons to defeat U.S. missile defenses. At the very least, hypersonic weapons add diversity to the range of missile threats currently facing the United States and its allies. Moreover, it is important to remember that hypersonic weapons in their current state only scratch the surface of hypersonic technology for next-generation missilery. As the technology advances, it is likely that hypersonic weapons will become faster, more maneuverable, and more reliable than current iterations. For military planners, who are tasked with anticipating threats up to 30 years in the future, considerations for hypersonic weapons should take this into account.

2. Strategic Consequences

Although some experts question the value of hypersonic weapons, a perception among government and military officials – accurate or not – that hypersonic weapons are uniquely capable of defeating missile defenses challenges the effectiveness of missile defense for both nuclear and conventional deterrence by denial, not only for the U.S. homeland, but for U.S. forces and installations around the world. Because of the challenges they pose for early detection and tracking, hypersonic weapons can compress decision-making timelines during a missile strike and increase uncertainty in the intended target. A recent RAND analysis indicates that using ground-based detection strategies, a 3,000 km-range ballistic missile could be detected 12 minutes before strike, whereas an HGV of the same range could only be detected six minutes before strike.[12] This is similar to the time frame of a close-range submarine-launched nuclear strike. The 50 percent reduction in available reaction time indicated by this analysis is significant. An independent analysis by the Nuclear Threat Initiative indicates that at least seven to eight minutes are required to locate the president and key advisers and get a response decision in the event of a missile attack on the U.S. homeland.[13] Compressed response time also challenges missile-defense targeting and interception by reducing the amount of time available to correlate data and accurately determine the target's position, thereby reducing the number of potential interception attempts.

The maneuverability of hypersonic missiles means that in the event of a hypersonic

attack, the intended target may not be known until near the end of the flight trajectory.[14] Some analysts argue that this target uncertainty may encourage nations to adopt a "strike-on-warning" nuclear deterrence policy by which a nation launches a retaliatory strike in response to an enemy nuclear strike before the enemy missile detonates.[15] During the Cold War, the United States adopted such a policy to deter a surprise submarine-based attack on U.S. nuclear missile sites. The rise of new potential nuclear delivery platforms including hypersonic weapons has revived debates over strike-on-warning policies. Although such policies are not universal, Russia, at least, appears to have joined the United States in adopting a strike on warning stance.[16]

Target uncertainty and compressed timelines may result in a higher chance that a misinterpreted missile test or missile launch may result in retaliation and increase the risk of inadvertent escalation in a crisis. For a ballistic missile, the flight trajectory can often be predicted with relatively low uncertainty only minutes into the flight, giving time to assess the origin and likely target of the missile. This information is critical in deciding whether or not to retaliate and whether retaliation should involve non-kinetic, conventional kinetic, or nuclear action. Hypersonic weapons pose a challenge for predicting intended targets, and since many hypersonic delivery vehicles can be armed with either conventional or nuclear warheads, they may pose a challenge for identifying whether an incoming strike is nuclear or conventional. This may increase the likelihood that, under a strike-on-warning policy, a state may misinterpret an attack and take action that inadvertently escalates a crisis.

Hypersonic weapons may also be used in conjunction with other precision-strike weapons for conventional deterrence. Both Russia and China are advancing their conventional deterrence capabilities, apparently to preclude a large-scale kinetic engagement with what they perceive as a superior U.S. conventional military force. Both Russian and Chinese concepts of conventional deterrence involve the possibility of precision strikes on critical military infrastructure to confuse and disable the enemy and prevent or force a cessation of hostilities. Because of their speed and maneuverability, hypersonic weapons can complement other precision-strike platforms in conducting these deterrence strikes, even in the presence of robust air and ballistic missile defenses.

3. Strategic Stability

The perception of novelty surrounding hypersonic weapons has contributed to a growing arms competition that threatens strategic stability at a time when arms-control agreements are deteriorating. In 2019, after several alleged Russian violations,[17] the United States pulled out of the 1987 Intermediate-Range Nuclear Forces treaty (INF),[18] meant to prohibit U.S. and Russian development of intermediate range missiles, including tactical nuclear weapons. In 2020, the United States withdrew from the 1992 multilateral Open Skies agreement,[19] which

facilitated aerial monitoring and data collection of U.S. and Russian weapons programs. This leaves New START (Strategic Arms Reduction Treaty), recently extended to 2026, which caps U.S. and Russian strategic weapons, as the only remaining arms control agreement in force between the United States and Russia. Efforts to involve China in trilateral arms-control agreements have so far been unsuccessful. As arms agreements break down, the United States, Russia, and China's pursuit of hypersonic weapons has often been characterized as an arms race. Although some analysts refute this characterization, Russia's hypersonic development appears, in many respects, to be caught in an action-reaction cycle with U.S. missile-defense development. Chinese hypersonic investments also appear somewhat influenced by the United States and Russia's development of hypersonic weapons and other high-technology warfighting capabilities. Meanwhile, it seems clear that the U.S. push for hypersonic weapons is driven, in large part, by the desire to maintain overall technological superiority over Russia and China.[20]

Global State-of-Play in Hypersonics

Russia and China lead the United States – and the world – in hypersonic arms development and deployment, which contributes to the perception of a hypersonic "missile gap" between the United States and its competitors. Because of the cost and technical challenge associated with hypersonic technologies, the majority of hypersonic weapons development takes place in these three countries. Both Russia and China report numerous successful tests of hypersonic weapons over the last five years, and both are expected to increase funding for hypersonic R&D.[21] Russia has reportedly fielded three or four hypersonic weapons systems, and China has fielded at least one. The United States is not expected to field any systems until the mid-2020s.[22]

China has a robust nationwide hypersonic program that includes advanced hypersonic testing infrastructure.[23] Most known Chinese systems in testing or in operation are theater-range HGVs, including the DongFeng 17 (DF-17), which is reportedly operational.[24] China has tested an HGV known as WU-14 (DF-ZF)[25] and is in advanced stages of testing the XingKong-2 (starry-sky) HCM.[26] China leads the world in open-source hypersonic research,[27] and it appears to have made significant advances in sustained hypersonic propulsion.[28]

Russia leads the world in deployed hypersonic technology, including the Avangard HGV, two hypersonic aeroballistic missiles known as the Kh-32 and the Kinzhal, and the air-to-air R-37 hypersonic missile. Russia has also touted several successful tests of the Tsirkon HCM over the past few years.[29] Although most contemporary Russian hypersonic research is classified,[30] Russian hypersonic weapons programs are supported by a long history of research, and Russia is known to have several strong ongoing hypersonic programs involving nearly 40 government laboratories.[31]

Russia also collaborated with India on the BraMos II anti-ship hypersonic missile,[32] and Australia works with the United States on the Southern Cross Integrated Flight Research Experiment (SCIFiRE), which intends to demonstrate an operational hypersonic scramjet engine capable of sustained thrust.[33] Several additional countries, including France, Iran, and North Korea,[34] are pursuing, or are known to have pursued, hypersonic capabilities.[35]

US hypersonic research and development has a long history, but consistent funding for research did not begin until recent years. U.S. policy focuses now on development of conventionally armed hypersonic weapons including both HGVs and HCMs. There are at least eight major hypersonic weapons programs (Table 1) currently underway in the United States, involving the U.S.Navy, Army, Air Force, and the Defense Advanced Research Projects Agency (DARPA).

Each of the programs aims at prototyping hypersonic platforms for future acquisition by the Department of Defense. The United States plans to have at least one hypersonic weapon in operation by the mid-2020s, although recent testing setbacks and cost concerns may postpone delivery.[36]

The perceived "missile gap" between Russian, Chinese, and U.S. hypersonic weapons may be, in part, due to a difference in objective.[37] Whereas Russia and China appear focused on nuclear and dual-use – both nuclear and conventional – hypersonic weapons, the United States pursues conventional systems only. Hypersonic flight poses unique challenges for accurate targeting.[38] Therefore, conventionally armed hypersonic weapons are more difficult to produce than their nuclear counterparts, which compensate for low accuracy using large blast radius. Thus, some analysts argue that Russia and China's focus on nuclear hypersonic weapons may be an attempt to compensate for deficiencies in accuracy and capability due to unresolved technical challenges.[39] Additionally, although Russia and China have fielded hypersonic weapons, analysts note that support systems required to operationalize hypersonic weapons systems at large scale have not emerged, suggesting that hypersonic use by either country will be limited for the near term.[40]

Nevertheless, it seems clear that hypersonic weapons development is of high priority to both Russia and China. To craft a U.S. defense policy response, it is important that U.S. policymakers consider the reasoning behind Russian and Chinese hypersonic programs. In light of recent events in Ukraine and Eastern Europe, this paper focuses on Russia's hypersonic development. The following sections examine Russia's current hypersonic capabilities, possible motivations for Russian hypersonic development, and the implications of Russian and U.S. policy related to hypersonic weapons for U.S.-Russian strategic stability.

Russia's Hypersonic Capabilities and Motivations

In order to understand Russia's motivations for hypersonic weapons, it is critical to understand the capabilities Russia is pursuing, major Russian threat perceptions, and key deterrence concepts in Russian strategic thinking. Important aspects from each of these areas are discussed in the following sections.

Russian hypersonic weapons development appears to have direct historical links to U.S. missile-defense development efforts. Both Russia and the United States engaged in various forms of hypersonic research as early as the 1940's. However, Russian hypersonic missile development does not appear to have begun in earnest until the 1980's, in response to the U.S. Strategic Defense Initiative (SDI). In response to SDI, the vice president of the USSR Academy of Sciences, E. P. Velikhov, proposed a program known as "asymmetric response" aimed at developing capabilities, including advanced missilery, to ensure U.S. vulnerability in the face of missile defense.[41] Several hypersonic missile programs emerged through the 1980's, but many were discontinued after the fall of the Soviet Union during the 1990's, likely due to high cost and lack of military funding.[42] However, since 2002, in response to the United States' withdrawal from the Anti-Ballistic Missile (ABM) Treaty, Russian hypersonic development has again accelerated.[43] Within the last 20 years, several Soviet hypersonic programs have been revisited, and some of these, in turn, have led to Russia's current hypersonic weapons systems.

Russian Hypersonic Weapons Systems

Russia has reportedly deployed more hypersonic weapons systems than any other country. Although Russia appears to purposefully keep the exact details of its programs hidden, some details of Russia's hypersonic platforms can be obtained from open-source information, as summarized in this section.

1. Avangard (Iu-71) HGV

The Avangard HGV was publicly announced by Putin in a 2018 address.[44] Russia has deployed at least two nuclear-armed Avangard units in the southern Urals[45] and reportedly plans to deploy ten additional units in the near future. From tests, it appears that Avangard is capable of carrying a two-megaton nuclear warhead with countermeasures[46] over 6,000 km at speeds of up to Mach 27.[47] Although it is currently deployed, it appears that Avangard is still in final stages of testing and is not yet fully operational.

2. Kinzhal (Kh 47-M2) Aeroballistic HCM

Kinzhal is an air-launched aeroballistic cruise missile that can travel at hypersonic speeds between Mach 5 to Mach 10.[48] Kinzhal is currently deployed on MiG 31 fighters, but it may be deployed on upgraded versions of the TU-22M3M bomber in

the next few years.[49]

3. Kh-32Aeroballistic Missile

The Kh-32 is a dual-capable (nuclear and conventionally armed) aeroballistic missile similar to the Kinzhal that can travel about 1000 km with a top speed between Mach 4 and Mach 5.[50] Like Kinzhal, the Kh-32 is reportedly intended to be deployed on both Su-30 fighters and upgraded TU-22M3M bombers.[51]

4. Tsirkon (3M-22)HCM

The Tsirkon is a new, dual-capable ship-launched HCM. Although there are some conflicting reports, Tsirkon likely has a range of between 600-1000 km.[52] In October 2020, Tsirkon reportedly traveled nearly 500 km, reaching speeds of around Mach 8, before hitting a floating target.[53] It appears that Tsirkon is planned to be deployed by 2022 on Russian vessels in the Asia-Pacific region.[54]

5. R-37 HCM

The R-37 is a hypersonic air-to-air missile with a reported range of up to 300 km and a top speed of around Mach 6. It is expected to be mounted on MiG 31BM fighters and the new Su-57 fighter.[55]

6. Additional systems

Russia appears to be developing several additional hypersonic systems. Although the true nature and state of these systems is generally not known, reports suggest that these systems include a small version of Kinzhal [56] to be mounted on the new Su-57 fighter, air- and land-launched versions of the Tsirkon [57] HCM, and at least one new HGV similar to the Avangard that is compatible with ICBM boosters other than the SS-19 and Sarmat.[58]

President Putin announced that Russia plans to develop capabilities to mass-produce hypersonic weapons in the coming years. However, most analysts argue that such capabilities will likely remain financially infeasible for the foreseeable future, particularly as Russia grapples with the severe economic fallout resulting from its recent invasion of Ukraine.[59]

Russian Threat Perceptions

Key to understanding Russia’s motivations for pursuing hypersonic weapons is to understand Russia’s world view and preoccupation with perceived threats from the United States and NATO, which is characterized by Russia expert Dima Adamsky as a “siege mentality.” According to Adamsky, the siege mentality “incorporates a sense of inferiority, reflecting a feeling of persecution and oppression, coupled with a feeling of superiority and grand strategic aspirations.”[60] Many Russian officials

view recent NATO and EU expansions as an active attempt to contain Russian interests[61] and undermine Russia's global influence.[62] This concern is compounded by a long history of costly foreign invasions of Russia, many of which came from the West.[63] In response, Russia works to create a buffer along its western periphery, often by coercion and sometimes by force, as evidenced by Russia's recent military actions in Ukraine. Russia's sense of vulnerability has likely been triggered as NATO military personnel and equipment extend into former Warsaw Pact nations. In 2014, Russian military doctrine indicated that the "build-up of the power potential" and "military infrastructure of NATO member countries near the borders of the Russian Federation" was the top external risk.[64] Russian political scientist Alexei Arbatov explains that Russia likely views even limited NATO forces in Eastern Europe as a "forward echelon" that may threaten Russian territorial sovereignty.[65]

Coupled with this "siege mentality" is a firmly established reliance on nuclear weapons in Russian strategic culture and defense strategy. Despite recent military modernization efforts, Russia maintains a sense of conventional military inferiority to U.S. and NATO forces.[66] Russia historically relied on nuclear weapons as an asymmetric means to compensate for military inferiority and preserve Russia's status as a world power. This reliance cemented the position of nuclear weapons in Russian strategic culture as a vital symbol of Russian statehood and Russian power.[67] Moreover, as noted by Adamsky, Russian nuclear weapons appear to have become intertwined with significant cultural and religious beliefs, which may further solidify their importance.[68] Although recent military modernization efforts have reduced Russia's reliance on nuclear weapons,[69] the most recent Russian military doctrine retains nuclear weapons as part of a holistic military strategy that incorporates conventional, informational, and nuclear technologies into a single approach.[70] Many in Russia still seem to view nuclear weapons as the only effective means for deterring a debilitating conventional attack by the United States and NATO.[71]

In the context of these perceptions, is not surprising that Russian officials would view U.S. missile defense as an underhanded attempt to weaken, or even nullify, Russia's nuclear deterrent.[72] In a 2015 address, Russian President Vladimir Putin said, "Recently the United States conducted the first test of the anti-missile defense system in Europe. What does this mean? … It was about an attempt to destroy the strategic balance, to change the balance of forces in their favor not only to dominate but to have the opportunity to dictate their will to all."[73] Putin also expressed concerns that U.S. missile-defense installations in Europe could be used in an offensive role against Russia. Noting the United States' clear superiority in precision-guided munitions and aerospace power, some Russian military experts and government officials connect U.S. missile defense to a larger perceived strategy intended to neutralize Russia's nuclear deterrent with massed aerospace attacks[74]

and precision strikes on nuclear weapons and command & control infrastructure,[75] relying on missile defense to defeat any remaining attempt to retaliate.[76] This connection between precision-strike and missile defense was likely exacerbated by the timing of the U.S. conventional prompt global strike program, which coincided with the U.S. withdrawal from the ABM treaty. Russia has long pushed back against U.S.missile defense by seeking asymmetric means to defeat missile defense and dissuade the United States from pursuing additional missile defense development.

Russian Motivation: Strategic Deterrence

Russian military strategy involves a cross-domain approach, incorporating both conventional and nuclear weapons, that reinforce concepts of "strategic deterrence"– or *sderzhivanie*– which encompasses both prevention and containment of conventional and nuclear aggression.[77] Russia's 2015 National Security Strategy defines strategic deterrence as a series of interrelated political, military, military-technical, diplomatic, economic, and informational measures to prevent the use of force against Russia, defend sovereignty, and preserve territorial integrity.[78] Russia military expert Michael Kofman explains, "The Russian goal has been to find deterrence answers to problems that do not have good warfighting solutions, to manage escalation, and to address the escalation dilemmas resulting from a force structure too inflexible to deter a strategic-level conventional attack or a regional conventional conflict against a militarily stronger adversary."[79]

Russian military and deterrence strategies involve influencing adversaries' decision-making indirectly through threats and directly through force.[80] In Russian military literature, deterrence is discussed not only in terms of fear inducement but also in terms of limited use of force with both conventional and nuclear weapons.[81] Russia often uses nuclear threats for coercive purposes.[82] Russian nuclear signaling may involve indirect nuclear threats, large-scale nuclear exercises, and weapons development. Use of fear-inducement tactics for deterrence is viewed by Russia as a continual process, intended for both peacetime and war for deterrence and coercive purposes. However, deterrence by limited use of force, or "forceful deterrence,"[83] is envisioned only for large-scale conflict scenarios. In this sense, deterrence by limited use of force includes elements that are more closely aligned with Western conceptions of compellence and coercion.[84] Forceful deterrence strategies in Russian military literature generally call for tailored strikes to impose progressive levels of "deterrent damage"[85] – or the minimum level of damage required to achieve a given deterrence aim – on critical enemy infrastructure to alter an enemy's cost-benefit analysis.[86] The purpose is to contain the spread or scope of an existing conflict, provide opportunities for de-escalation, and leverage an asymmetry of stakes to discourage further conflict.

Forceful deterrence is mentioned specifically in the 2014 Russian military doctrine

and supported by discussion of strikes using conventional high-precision weapons for coercive purposes.[87] Typically, during a military conflict, damage would be inflicted in a dosed manner, beginning with conventional strikes. However, many Russian analysts emphasize that conventional weapons will not necessarily replace nuclear weapons for regional and global deterrence.[88] In Russian military thought, conventional deterrence is intimately tied with nuclear deterrence. Some Russian military writers note that using conventional weapons gives more credibility and flexibility to Russia's nuclear deterrent.[89] Many Russian discussions on forceful deterrence strategies envision the use of nuclear weapons at certain phases of conflict.

Russia's preoccupation with countering missile defense is also likely heavily influenced by fundamental differences between Russian and Western deterrence thinking. Missile defense is an integral part of U.S. strategy of deterrence by denial, intended to deter a nuclear strike by convincing a would-be adversary that any such strike could be defeated once launched. However, Kofman notes that the idea of "denial" is seldom discussed in Russian deterrence literature. Instead, Russian deterrence thought tends to focus on preventing threats from arising, rather than defeating a threat after it arises.[90] This is consistent with what some analysts describe as a Russian preoccupation with preemption over defense.[91] According to Kofman, Russia retains a "lingering fear of strategic surprise…and the belief that if escalation is likely, then Russia should take the lead rather than attempt a costly defense."[92] While Putin has denied that preemption is part of Russia's nuclear doctrine,[93] it is possible that through mirror imaging, this thinking may be contributing to Moscow's fear that missile defense is part of an offensive U.S. decapitating strike capability intended to neutralize Russia's nuclear arsenal.

The Role of Russian Hypersonic Weapons

Russia seems to view hypersonic weapons both as an important conventional warfighting capability and as an effective tool to enhance and safeguard Russia's deterrence capability and preserve strategic stability in the face of perceived efforts by the United States and NATO to undermine Russian influence and destabilize the strategic landscape. Nearly all of Russia's hypersonic platforms are dual-capable, or capable of carrying both nuclear and conventional payloads. Because Russia's military doctrine adopts a holistic strategy in which conventional and nuclear weapons are tied together, hypersonic weapons, even when conventionally armed, are likely tied to Russian nuclear thinking.

Details about the development of the Avangard HGV, coupled with statements by Russian officials, suggest that Avangard was specifically motivated by a desire to protect Russia's strategic nuclear deterrent from U.S. missile defense and discourage future missile defense development.[94] In 2019, Putin justified the development of Avangard by saying that it was preferable to permitting the United States "to secure

some serious strategic advantage for themselves" with missile defenses.[95] He characterized Avangard as "unstoppable" by U.S. missile defense. Since Moscow views missile defense as an underhanded and destabilizing attempt to nullify Russia's deterrent, it is likely that Avangard is intended to "restore" strategic stability between the West and Russia, not only by providing a nuclear delivery option that can easily bypass missile defense, but also by dissuading the United States from pursuing missile-defense technologies altogether. This strategy is consistent with the intent of the Soviet "asymmetric response" to SDI in the 1980's, which was to disincentivize U.S. missile-defense development by developing advanced weapons. In fact, development of Avangard began with Russia's "asymmetric response" to SDI, before it was reinstated in the 1990's as project 4202 and accelerated in the early 2000's.[96] Putin referred to Avangard as an"asymmetric, but very serious response"[97] to U.S. missile-defense policies.The idea that the development and use of advanced weapons by Russia may incentivize rather than discourage U.S. weapons development is rejected by Moscow.[98]

Russia possesses many missile systems in quantities or with capabilities that allow them to overwhelm or bypass missile defense. It is possible that Russian leadership recognizes this but also recognizes the psychological and deterrence advantage of Avangard as a symbol of Russian superiority. This may shed light on why Avangard appears to have been deployed before it was fully operational. It may be that Russian leaders saw early deployment of Avangard as a chance for Russia to reap some of its deterrence benefits while completing final phases of testing. The idea of Avangard as a symbol of superiority may also explain Russia's recent decision to fund Avangard at the expense of delaying the Braguzin rail-mobile ICBM launcher, which arguably has greater deterrence capability and value than Avangard under traditional Western deterrence principles.

Russia's dual-capable regional- and theater-range hypersonic systems, such as the Kh-32, Kinzhal, and Tsirkon, could be used to advance Russia's deterrence and coercion capabilities by threatening critical NATO targets. These hypersonic weapons complement conventional precision-strike capabilities by adding speed, range, and flexibility to Russia's conventional and non-strategic nuclear missile arsenal. Based on the ranges reported by some Russian officials, conventional or nuclear-armed versions of Kinzhal based in Russia could threaten U.S. or NATO targets in Turkey, Syria, Iraq, Israel, East Asia, and points as far west as Paris, as far south as Dubai, and as far east as Anchorage. Holding targets such as these at risk could enhance Russia's ability to project its influence in Eastern Europe and prevent NATO intervention in military actions along its periphery. In a Russia/NATO conflict scenario, Russia's hypersonic weapons could also expand the range of possible targets that could be held at risk as part of a forceful deterrence strategy.

Some analysts suggest Russia may perceive conventionally armed hypersonic

weapons as a means to achieve the benefits of low-yield nuclear weapons without the same implications.[99] Because of their speed and high inertia, hypersonic weapons are capable of delivering higher intensity strikes than other conventional missiles. By leveraging this capability, Russia may be able to neutralize targets in a conventional conflict that were once only vulnerable to nuclear strikes. However, it appears that Russian hypersonic weapons have principally been deployed as part of Russia's deterrence forces.

United States Response: Technological Superiority

The U.S. response to Russian hypersonic development has primarily been based on establishing and maintaining technological superiority.[100] Although this is important to U.S.strategy, it appears to be stoking Russia's fears that the United States will gain a strategic advantage that will destabilize the deterrence landscape in Europe.

The United States is accelerating funding in offensive hypersonic weapons research. Michael White, head of hypersonic development in the Department of Defense's (DOD) Office of the Undersecretary of Defense for Research and Engineering, indicated that the United States plans to spend $14 billion in hypersonic research and development over the next several years.[101] In FY 2021, the DoD requested $3.2 billion for hypersonic research,[102] with $207 million devoted to hypersonic missile defense;[103] this increased to $3.8 billion for hypersonic strike maturation[104] and nearly $250 million for hypersonic missile defense during FY 2022.[105]

The three current U.S. missile defense systems – the Ground-Based Interceptor (GBI), Terminal High-Altitude Area Defense (THAAD), and Aegis – are all either outdated, provide limited protection area, or employ a limited number of interceptors. Each is designed to intercept the ballistic missiles during midcourse or in the terminal phases of flight, when not only hypersonic weapons, but many other maneuverable missiles, can maneuver and evade interception. Moreover, even with a 1:1 intercept ratio, which is highly optimistic, current U.S. systems do not have enough interceptors to counter a large salvo launched by Russia or China.[106] Thus, the current U.S. missile defense system is best suited to counter threats from rogue states with relatively small arsenals of less-advanced ICBMs rather than larger nuclear powers such as Russia or China. However, Russia's focus on defeating U.S. missile defense highlights vulnerabilities in the U.S. missile defense system that could be exploited by rogue states with hypersonic weapons.

Therefore, the United States is working hard to update existing missile defense systems to counter hypersonic and other new missile threats. In 2018, the Missile Defense Agency (MDA) began an effort to develop counter-hypersonic weapons systems called the Hypersonic Defensive Weapons System (HDWS).[107] In 2019,

MDA announced a new counter-hypersonic weapons prototype program called the Regional Glide Phase Weapon System (RGPWS).[108] In the past few years, MDA also placed an emphasis on upgrading existing GBI, THAAD, and sea- and land-based Aegis missile defense systems. In fact, the FY 2021 budget for MDA included $1.9 billion for support and expansion of the Ground-based Mid-course Defense (GMD) system, $1.8 billion to upgrade the Aegis weapon system and procure additional interceptors, and $1 billion for upgrades and interceptor procurement for THAAD.[109]

Because of their maneuverability and unusual altitude, detection and tracking of hypersonic weapons is best accomplished by space-based sensors. Once separated from the booster, hypersonic weapons are typically 10-20 times dimmer than ICBMs.[110] Therefore, such a space-based system requires advanced infrared sensors for tracking. The United States is developing such a system for tracking both hypersonic weapons and ICBMs as a partnership between MDA and the Space Development Agency (SDA).[111]

In November 2020, MDA conducted the first successful ICBM intercept test of its Aegis sea-based interceptor, prompting a predictable condemnation by Russia. Given Russia's ongoing fight against missile defense, it is likely that the continued advancement of missile defense by the United States will spur reciprocal advancement of hypersonic weapons in Russia. A continued action-reaction cycle between U.S. missile defense and Russian hypersonic development could lead to an arms race that challenges strategic stability and heightens tensions between Russia and the West.

Balancing Technological Development and Arms Control: Recommendations for the United States

Safeguarding U.S. assets, personnel, operations, and domestic security, while preventing action-reaction dynamics that could fuel an offense-defense arms race requires a comprehensive response that balances research and development of hypersonic strike and missile defense capabilities with confidence building, restraint and multilateral arms control to prevent proliferation of hypersonic technology. Such an approach can be facilitated by coordinated actions from the Department of Defense (DoD), the State Department, Congress, and the Intelligence Community, as described in this section.

As hypersonic military technology advances, particularly among peer and near-peer competitors, continued research and development of hypersonic offensive strike weapons will be valuable to ensure national security and maintain military credibility moving forward. United States hypersonic development has been focused on high-accuracy conventional strike, and in light of the limited effect that nuclear-armed hypersonic weapons are likely to have on the deterrence status quo,

continued focus on conventional strike appears to be prudent. DoD funding and collaboration between DARPA, the Navy, the Air Force, and the Army on existing prototype programs is key to closing the perceived "missile gap" between the United States, Russia, and China.

In order to efficiently develop and field hypersonic offensive strike capabilities, it is critical that DoD establish a clear doctrine for hypersonic weapons. Currently, it appears that the mission requirements and objectives of hypersonic weapons are not well defined. Since hypersonic weapons are under development by all branches of the U.S. military, these systems would benefit from creation of military doctrine by the Joint Chiefs of Staff (JCS) regarding use of hypersonic weapons for strategic and tactical purposes. To frame hypersonic weapons in their appropriate context, the JCS could include in joint hypersonic doctrine a taxonomy for missile systems that abolishes outdated missile categories and defines new ones spanning the spectrum of near-term range, speed, and maneuverability.[112]

It is also important that the United States continue to focus funding and development on hypersonic missile detection & tracking and research & development of alternative hypersonic missile defense strategies, including evasion, hardening, point-defenses, and military deception. Effective detection & tracking requires updating of space-based sensors for early hypersonic detection. Although existing Space-Based Infrared (SBIR) sensors sense and track hypersonic glide vehicles, additional development is needed to track smaller and dimmer hypersonic cruise missiles. The Hypersonic and Ballistic Tracking Space Sensor (HBTSS) under development by MDA and SDA is meant to detect and track hypersonic glide and ballistic missiles.[113] Sensors for hypersonic cruise missiles could be added to this program. Efforts by DoD to advance U.S. hypersonic missile detection & tracking capability and alternative missile defense strategies will require Congressional approval. While Congress acquiesced to DoD's funding requests in the recent past, it will be critical that Congress sustain funding even as administrations change and defense priorities shift.

The threats posed by Russian nuclear-armed hypersonic weapons and the potential for hypersonic arms-race instability could be addressed to some degree by working to build confidence with Russia through dialogue and a careful mixture of restraint and targeted development of certain missile-defense components. This first requires that U.S. officials recognize and acknowledge Russia's deep-rooted perceptual lens. In light of Russia's longstanding concerns surrounding U.S. missile defense, clear effort should be made to reopen dialogue with Russia and reemphasize, by both word and action, the primary purpose of missile defense, which is to counter threats from rogue states and non-state actors.[114] This stance could also be clarified in joint doctrine regarding missile defense.[115] This would enhance continuity between official military doctrine and statements of purpose in the 2019 Missile

Defense Review and provide a clear foundation from which the U.S. could engage with Russia in arms-control discussions.[116]

However, since Russian preoccupations stem from strategic and cultural elements, it is unlikely reassurances will allay Russian concerns without real U.S. concessions on missile defense. These could be accomplished by considering concessions on deployment and fielding of hypersonic interceptors, perhaps limiting current funding for hypersonic interceptors to research & development only. United States officials concede the U.S. nuclear arsenal, not missile defense, remains the main deterrent against a nuclear hypersonic attack from Russia or China. Since the stated purpose of missile defense is to defend against rogue states and non-state actors and the lion's share of foreign advanced hypersonic weapons development is likely to be in Russia and China, concessions on mid-course hypersonic interceptors may alleviate Russian concerns without exposing the United States to any significant new vulnerability from Russia or China. Smart concessions could be used in arms-control and non-proliferation discussions to provide a powerful incentive for Russia and China to engage in multilateral agreements.[117]

For such concessions to be feasible, however, the United States would need commitments from Russia, China, and any other country involved in hypersonic research to prevent proliferation of hypersonic technologies and equipment to rogue states or non-state actors. Advancing hypersonic non-proliferation measures under the Missile Technology Control Regime (MTCR) is one possibility that could limit spread of hypersonic technologies and provide common ground from which the United States and Russia could engage China. If Russia or China were unwilling to enter arms arrangements, the United States could partner with international allies, including NATO or UN Security Council members. International hypersonic arms-control and nonproliferation agreements, perhaps in conjunction with the nuclear Non-Proliferation Treaty (NPT), could become part of an international pressure campaign to push Russia and China toward compliance. Because nearly all of Russia's hypersonic delivery platforms are dual-capable, it may be valuable to seek an inspection and verification agreement for warheads on dual-capable weapons systems, including hypersonic weapons. Such an agreement could include warhead verification and storage location requirements to reduce warhead ambiguity, prevent unintentional escalation, and mitigate potential crisis instability. These verification provisions would likely require joint efforts among government agencies, including the State Department, the Department of Energy, and the Intelligence Community. The idea would be to expand strategies for alternative HUMINT, SIGINT, and FISINT collection and analysis of Russian and other foreign weapons programs; develop novel strategies for warhead verification; and ensure safe operation of national technical means (NTM) to ensure agreement compliance.

Finally, interagency analyses regarding cultural motivators shaping development of

hypersonic and other advanced weapons in Russia, China, and other nations of interest should be ongoing. Understanding these motivations is critical to assessing the threat that hypersonic weapons pose to U.S. national security. Analyses could be included as a standalone report or amendment designed to complement government documents such as the Department of Defense *Nuclear Posture Review* or the Defense Intelligence Agency *Military Power* publications.[118]

Conclusion

Russia's hypersonic weapons development appears to be tied to a desire for technologies that ensure U.S. targets remain vulnerable regardless of advances in American missile defense. Russian concerns about U.S. missile defense are driven in turn by longstanding strategic and cultural beliefs that amplify Russia's threat perception from the West. Based on Russian military doctrine and literature, Russian hypersonic weapons appear to be meant to enhance Russia's conventional and nuclear deterrence strategies, both psychological and kinetic, with respect to the United States and NATO. The United States is responding to Russia's hypersonic weapons development by seeking superiority in this technology through development of both hypersonic offensive strike and hypersonic missile defense capabilities. However, if unrestrained, and if pursued in the absence of other confidence-building measures, this approach will simply fuel foreign hypersonic development. Instead, to discourage a destabilizing hypersonic offense-defense arms race and safeguard U.S. national security, the United States can consider focusing missile-defense funds on hypersonic detection & tracking and alternative missile-defense strategies other than hypersonic interceptors. In addition, hypersonic research & development should be paired with multilateral non-proliferation and verification agreements to prevent the spread of hypersonic weapons, especially to rogue states and non-state actors operating outside any arms control context.

Table 1: Major U.S. Hypersonic Weapons Programs[119]

Program Title	Primary Agency
Tactical Boost Glide (TBG)	DARPA
Advanced Full-Range Engine (AFRE)	DARPA
Operational Fires (OpFires)	DARPA
Hypersonic Air-breathing Weapon Concept (HAWC)	DARPA
Intermediate Range Conventional Prompt Strike Weapon (IR CPS)	US Navy
Land-Based Hypersonic Missile (Long Range Hypersonic Weapon)	US Army
Hypersonic Conventional Strike Weapon (HCSW)	US Air Force
AGM-138A Air Launched Rapid Response Weapon (ARRW)	US Air Force

[*]Jeffrey Taylor is Ph.D. candidate in Mechanical and Aerospace Engineering at the Center for Anticipatory Intelligence, Utah State University.

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