Politeja
No. 4(79), 2022, pp. 37-54
https://doi.org/10.12797/Politeja.19.2022.79.03

Marek CZAJKOWSKI
Jagiellonian University in Kraków
marek.czajkowski@uj.edu.pl

HYPERSONIC WEAPONS – SELECTED POLITICAL AND STRATEGIC ISSUES[1]

ABSTRACT This article aims to shed some light on the impact of the emergence of hypersonic weapons on strategic and political realities. Firstly, it briefly describes the underlying laws of physics and technologies related to hypersonics. Secondly, it investigates the strategic and political consequences of developing the new weapons systems. The general assumption is that already fielded hypersonic weapons systems, and those that will enter service in the foreseeable future will not significantly change the global strategic balance. It is because, to a great extent, disadvantages offset the advantages the technology may provide. On the other hand, the political significance of developing hypersonic military technology is much higher, as it is a source of prestige, particularly important from the Chinese and Russian points of view.

Keywords: international security, strategic stability, Russia, China, United States, hypersonic weapons, ballistic missiles

[1] This article is largely based on two previous texts which were published by this Author in the Internet but were never peer-reviewed: "Hypersonic Missiles – a Political Multipurpose Weapon", *Analiza Zakładu Bezpieczeństwa Narodowego UJ*, no. 4(43) (2019), at https://zbn.inp.uj.edu.pl/documents/92718966/141790394/Czajkowski+-+Analiza1/1cfa6113-361a-4ef8-b3d9-53bc-659c6cd1, 10 March 2022; and "Hypersonic Hype Revisited", *Analiza KBN*, no. 14(94) (2021), at https://zbn.inp.uj.edu.pl/documents/92718966/141790394/Analiza94-Czajkowski-1/5f19cf91-7193-49c8-a11f-0fdde811be66, 10 March 2022. For the purpose of this article, the abovementioned texts were updated and revised to reflect Author's current knowledge.

1. INTRODUCTION

In the last several years, hypersonic weapons have become a very popular leitmotif of the debates concerning the national security of many nation-states and international security. Hypersonic technology gets attention mainly because it is often supposed to alter the existing strategic balance, particularly in favor of Russia and China. Thus, in the United States, and to a lesser extent in the other Western countries, a chorus of alarming voices is underscoring the purported American backwardness.[2] These voices are also calling for higher funding and a quicker pace of research and development (R&D) efforts to field own hypersonic weapons and create capabilities to counter the enemy's systems of that sort.

It seems worthwhile to attempt to grasp the real influence of the new but steadily maturing technologies on international security. Hence, this article aims to shed some light on the impact of novel weapons on strategic and political realities. Therefore firstly, we will shortly depict the underlying laws of physics and technologies related to hypersonics. Secondly, we will investigate the strategic and political consequences of developing the new weapons systems.

The research has been conducted mainly along the realist paradigm within IR. This choice seems obvious, as far as strategic considerations regarding relations among world powers are presented. However, as the perceptions of decision-making apparatus are also examined, the constructivist approach will be applied selectively. Publicly available technical data and other open-source information will form the bulk of the technical-operational analysis. At the same time, the strategic and political assessments will be conducted using qualitative methods encompassing primarily content analysis and discourse analysis. The study is based on desk research.

2. HYPERSONIC WEAPONS 101

If we intend to assess whether hypersonic weapons change strategic realities and how they impact political processes, we must understand the technology itself and its main characteristics. Therefore, our first task is to present basic terminology regarding these weapons and the physics principles that determine their features. We deem it necessary because novel weapons' impact rests on their attributes, and so we have to know what capabilities exactly we are talking about and how they are different vis-à-vis existing weapons systems. The description will be as short and general as possible; see our previous findings[3] and publicly available technical assessments[4] for more detailed information.

---

[2] See for example: R.J. Smith, "Hypersonic Missiles Are Unstoppable. And They're Starting a New Global Arms Race", *The New York Times Magazine*, 19 June 2019, at https://www.nytimes.com/2019/06/19/magazine/hypersonic-missiles.html, 22 July 2019.

[3] M. Czajkowski, "Hypersonic Missiles...".

[4] For example: S. Bugos, K. Reif, "Understanding Hypersonic Weapons: Managing the Allure and

The Mach number (Ma or M) is a physical unit of measure which refers to the velocity of an object travelling through the air relative to the speed of sound. Starting at the so-called transonic speeds (from Ma 0.8 on), an aircraft becomes subject to physical phenomena not occurring at lower speeds. Around Ma 5, airflow gains some very important characteristics absent at lower velocities (discussed below in more detail), hence the special term 'hypersonic flow'. Consequently, the word 'hypersonic' refers in principle to any vehicle that travels in the atmosphere with a speed of Ma 5 or higher.

A hypersonic craft may be unpowered or powered. The former refers to objects travelling along ballistic trajectories or gliding using a lift produced by a vehicle while it moves through the air. The latter refers to an object that is constantly propelled, which allows it to sustain a certain altitude, for it can produce sufficient thrust to maintain its lift. So, the most general division of hypersonic weapons entails the three following categories:

– a vast family of ballistic missiles, represented by several categories which differ in speed, range, and other properties. They, or their warheads, usually become hypersonic objects when they return to the atmosphere travelling along a ballistic path. It is, let us say, a traditional, widely used and well-known hypersonic vehicle – though ballistic missiles are usually not referred to as such.
– boost-glide vehicles, aka hypersonic glide vehicles (HGVs). In the most general understanding, this term refers to an unpowered re-entry craft which is accelerated by the launcher's rocket motor(s) and then is jettisoned at some altitude. After the release, an HGV ascends and subsequently descends along a ballistic trajectory for some time (it may also skip this ballistic part of the flight at the expense of range). Next, an HGV maneuver to level its flight more or less and to glide on due to aerodynamic lift. But at the moment it starts maneuvering, it also slows down – the more tangential to horizontal is its flight path, the quicker it decelerates. Furthermore, the lower it flies, the more rapid deceleration occurs because of mounting atmospheric drag. Evasive maneuvers also contribute to the decreasing of the speed of an HGV. As the maximum range of the glider depends on its initial speed, any deceleration caused by maneuvers shortens the flight's duration.[5] Another important characteristic of this kind of weapon is that it must sustain excessive heat generated by friction with the atmosphere. HGVs may be able to achieve various speeds, altitudes, and ranges, and their trajectories may vary according to different operational needs reflected in the capabilities of a given weapons system.
– hypersonic cruise missiles (HCMs). An HCM is a vehicle that does not follow a ballistic trajectory at all because it is continuously propelled, which makes it capable of sustaining long-distance maneuverable horizontal flight. Two main obstacles must be overcome to perfect the technologies necessary to build an HCM. The

the Risks", Arms Control Association Report, September 2021, at https://www.armscontrol.org/reports/2021/understanding-hypersonic-weapons, 15 March 2022.

5 A. Mahshie, "Hypersonics Defense", *Air & Space Forces Magazine*, 19 January 2022, at https://www.airforcemag.com/article/hypersonics-defense/, 16 March 2022.

first problem, of the foremost importance, concerns propulsion. Rocket motors are not applicable due to their immense fuel consumption, so an air-breathing system must be used. It means that a special kind of engine that would work at hypersonic speeds, called scramjet, must be constructed, what entails a host of technical complications. Furthermore, difficulties in developing hypersonic air-breathing propulsion amount exponentially if a given engine is to operate within a wide range of velocities and/or at various altitudes. Therefore, hypersonic-powered vehicles currently being tested are accelerated by rocket boosters to the speeds at which they can engage their scramjet engines. Another important problem of a powered hypersonic missile, which it shares with unpowered ones, is the heat that impacts an airframe as a vehicle moves through the air. Note that ballistic missiles must withstand it just for seconds, hypersonic gliders start their struggle with atmospheric drag at high altitudes in the relatively thin air – they are supposed to enter the densest layers only seconds before the actual impact. Conversely, hypersonic cruise missiles are exposed to excessive heat during the entire flight – the lower and faster they fly, the stronger this effect is because atmospheric drag increases with velocity squared and air density.

These technical realities are reflected in the operational realm once the use of hypersonic weapons is considered. In the most general terms, their impact on strategic balance may be as follows.

- Ballistic missiles are the most common, well-known hypersonic vehicles. Their construction is based on highly adaptable technology that was perfected decades ago. They have well-understood characteristics and hold an established place in the arsenals of many countries. Therefore, ballistic missiles of various kinds have a share in global and regional power balances. And that is why they are an obvious reference point as long as any other long-range strike system is considered.
- Boost-glide hypersonic weapons, already deployed in limited quantities by Russia and China and under development in other countries, do have some advantages over ballistic missiles. Particularly, the ability to fly at lower altitudes and better maneuverability seem crucial features of currently fielded HGVs. Thus, they seem particularly suitable for conducting special missions such as attempts to decapitate the enemy's political authorities or surgical, disarming strikes against key civilian or military infrastructure. Yet, these weapons have their disadvantages, too. The most important of them stem from the properties of hypersonic flow, which induces hot plasma on the surface of a craft. Thus, an HGV travels surrounded by a sort of heat sheath that dramatically complicates communication with the weapon, its navigation and targeting. The faster it travels, the more difficult it is to guide it, including self-guiding systems.[6] Furthermore, the heat trail that the weapon leaves in the atmosphere is relatively easy to track by properly calibrated sensors, what helps defeat a missile. The weapon may also be easier to track and intercept due to its lower

[6] P. Luzin, "Russia's Race for Hypersonic Weapons", *Eurasia Daily Monitor*, vol. 18, no. 170 (2021), at https://jamestown.org/program/russias-race-for-hypersonic-weapons/, 15 March 2022.

speed compared to the ballistic missile of a similar range.[7] Therefore, despite the advantages, a significant change of the strategic balance in favor of those who would field such weapons is not likely to occur for two reasons. Firstly, current and prospective ballistic missiles of various kinds are already extremely accurate and fast, and they are also mostly invulnerable to the existing missile defenses. A weapon with somewhat augmented capabilities would be useful in many cases but would rather not be critically important for the overall military balance.[8] Secondly, due to their complexity and steep price, hypersonic boost-glide systems are not destined to replace current offensive capabilities based on ballistic missiles any time soon.

– long-range hypersonic cruise missiles would become the real game-changer, the way the subsonic ones became in the 1970s when they were introduced into service. The most important is that such a craft is supposed to fly relatively low in comparison to ballistic missiles and even boost-glide vehicles. It would make them much less visible to the ground-based sensors, augmenting survivability and contributing to the ability to conduct surprise attacks on critical targets. However, due to technical difficulties with developing such missiles, their operational use is a matter of a rather distant and vague future. So, their capabilities, particularly the balance between advantages (speed, range, operational ceiling) and disadvantages (heat trail, guidance problems, and cost), remain to be determined. It is, however, safe to say that the ultimate kind of HCM, a sort of 'tomahawk on steroids', a ground-scratching, maneuverable long-range missile, travelling at tree-tops level 6 or 7 times faster than existing subsonic cruise missiles, is not going to materialize in the foreseeable future unless an unexpected technology breakthrough occurs.

3. HYPERSONIC WEAPONS SYSTEMS – STRATEGIC ASSESSMENT

Only a few hypersonic weapons systems have been recently declared operational; several more are due to enter service soon. However, the real capabilities of these systems remain, for the most part, unknown. Firstly, the obvious secrecy veil surrounds military technology, especially the most advanced weaponry. Secondly, deliberate disinformation is being distributed together with politically motivated bragging about alleged achievements of a given nation, its technological prowess, and the power of novel weapons it wields. It is, therefore, difficult to precisely assess the impact of certain weapons systems on the military balance, but we will anyway try to do so, at least in the most general terms.

Below, we will discuss several weapons referred to as hypersonic, which either have already been fielded or are being frequently discussed publicly. We will briefly evaluate

[7] C.L. Tracy, D. Wright, "Modeling the Performance of Hypersonic Boost-Glide Missiles", *Science & Global Security*, vol. 28, no. 3 (2020), pp. 135-170.

[8] D. Kunertova, "Weaponized and Overhyped: Hypersonic Technology", *CSS Analyses in Security Policy*, no. 285 (2021), p. 3, at https://css.ethz.ch/content/dam/ethz/special-interest/gess/cis/center-for-securities-studies/pdfs/CSSAnalyse285-EN.pdf, 15 March 2022.

these systems and related technologies, pointing to their possible impact on strategic stability as well. Note that Russia, China and the United States are the most advanced countries in hypersonics, but some other nations like Japan,[9] India,[10] France, UK, Germany and South Korea[11] have followed suit and invested in similar technologies.

The following description is very general and avoids most of the technical and organizational issues; for more detailed information, see our previous texts[12] and existing open-source analyses.[13]

3.1. Russia

Russian authorities advertise three systems as novel hypersonic weapons, claiming that they significantly shift the global military balance in Russia's favor.

The H-47M2 Kinzhal (X-47M2 Кинжал) is an air-launched variant of a short--range ballistic missile (SRBM) 9K-720 Iskander (U.S. DoD designation SS-26, NATO reporting name Stone), it is therefore not a new technology at all. Its deployment, so far in limited quantities,[14] somewhat augments the already existing capabilities[15] to strike at a range of 2000 km[16] but surely is not a strategic game-changer.

The 3M22 Tsirkon (3M22 Циркон) purportedly is a hypersonic Ma8-11 anti-ship missile of a range of about 1,000-2,000 km, although it is believed to be fired only at the distance of 350-500 km[17] so far. Unfortunately, reliable information about this missile is so scarce that it is even impossible to tell which category of hypersonic weapons it

9 E. Shim, "Japan to Develop Hypersonic Missile for »Defense Purposes«", United Press International, 19 September 2018, at https://www.upi.com/Top_News/World-News/2018/09/19/Japan-to-develop-hypersonic-missile-for-defense-purposes/9911537361251/, 24 February 2022.

10 "DRDO Successfully Flight Tests Hypersonic Technology Demonstrator Vehicle", Press Information Bureau Government of India Ministry of Defence, 7 September 2020, at https://pib.gov.in/Pressreleaseshare.aspx?PRID=1651956, 10 March 2022.

11 S. Trimble, "U.S. Hypersonic Programs Look to Recover Momentum in 2022", Aviation Week Network, 16 December 2021, at https://aviationweek.com/defense-space/missile-defense-weapons/us-hypersonic-programs-look-recover-momentum-2022, 15 March 2022.

12 M. Czajkowski, "Hypersonic Missiles..."; idem, "Hypersonic Hype...".

13 See for example: *Hypersonic Weapons: Background and Issues for Congress*, Congressional Research Service, 19 October 2021, at https://sgp.fas.org/crs/weapons/R45811.pdf, 2 March 2022.

14 P. Butowski, "Russia Creates Its First Hypersonic Strike Regiment", Aviation Week Network, 20 January 2022, at https://aviationweek.com/defense-space/aircraft-propulsion/russia-creates-its-first-hypersonic-strike-regiment, 15 March 2022.

15 "AS-15 Kent (Kh-55 Granat)", Missile Defense Advocacy Alliance, June 2017, at https://missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/russia/as-15-kent-kh-55-granat/, 24 February 2022.

16 "Kh-47M2 Kinzhal", Military-Today.com, at http://www.military-today.com/missiles/kh_47m2_kinzhal.htm, 24 February 2022.

17 M. Episkopos, "Russia's Hypersonic Tsirkon Missile: Just How Dangerous Is It?", The National Interest, 20 July 2021, at https://nationalinterest.org/blog/buzz/russia%E2%80%99s%C2%A0hypersonic%C2%A0tsirkon%C2%A0missile-just-how-dangerous-it-190004, 2 March 2022.

falls to. Thus, we cannot precisely assess the possible impact of this missile's deployment on the strategic balance because its actual capabilities are unknown. However, putting all the technicalities aside, our guesstimate is that the Tsirkon is a low-flying ramjet/scramjet missile with some 500 km of range and speed around Ma 5. It certainly adds to the overall firepower of the Russian navy but is not a strategic game-changer.

The Avangard (Авангард) is a truly novel technology, a boost-glide intercontinental vehicle, launched atop UR-100 NUTTH ICBM (SS-19, Stiletto). Initial plans[18] envisioned that by 2021 six missiles should enter service, and the total Avangard force should consist of two six-unit regiments by 2027. The detailed technical characteristics, especially the trajectories the glider can follow, are not known publicly, but the Avangard surely represents a powerful weapon of an intercontinental range, particularly suitable for conducting surprise attacks against high-value targets. It is, therefore, certainly an important addition to the Russian deterrence capability. But given that the strategic balance hinges on hundreds of strategic delivery vehicles with well over a thousand deployed warheads,[19] a dozen more do not change it significantly. It is often stressed that the Avangard has a superior capability to overcome missile defense systems. But it is rather irrelevant because modern and prospective delivery systems other than hypersonic are also, for the most part, undefeatable. Plainly speaking, ballistic missiles with swarms of decoys and other penetration aids employing multiple defense evasion or saturation attack patterns are unstoppable with current and prospective antimissile weapons. And this is not likely to change in the foreseeable future, as we often maintain.[20] Thus, the Avangard does not make any important difference in the strategic balance, especially given its limited procurement rate.

All in all, the new Russian hypersonic weapons or systems advertised as such do not alter the military balance in any significant way, even though they are surely valuable additions to the Russian arsenals. Furthermore, Russia lacks the industrial base and technology necessary to expand procurement of these novel weapons and make them more effective.[21] There are also important economic constraints within the Russian industry that impede the development of hypersonic weapons.[22]

---

18 P. Podvig, "Deployment of Avangard Continues in Dombarovskiy", Russian Strategic Nuclear Forces, 16 December 2020, at https://russianforces.org/blog/2020/12/deployment_of_avangard_continu.shtml, 25 February 2022.

19 Bureau of Arms Control, Verification and Compliance, *New START Treaty Aggregate Numbers of Strategic Offensive Arms*, U.S. Department of State, 1 September 2021, at https://www.state.gov/wp-content/uploads/2021/09/09-28-2021-September-NST-FACTSHEET-draft-Copy.pdf, 25 February 2022.

20 See: M. Czajkowski, "Ballistic Missile Defence – Technology, Effectiveness and Organization – Key Issues", *Politeja*, vol. 14, no. 5(50) (2017), pp. 227-262.

21 P. Luzin, "Russia's Race...".

22 S. Kaushal, "Putting the Russian Hypersonic Threat in Perspective", RUSI Commentary, 28 September 2021, at https://www.rusi.org/explore-our-research/publications/commentary/putting-russian-hypersonic-threat-perspective, 16 March 2022.

3.2. China

When assessing the Middle Kingdom's military capabilities, we encounter obvious and well-known information noise surrounding all of China's high-tech weapons programs. It is, therefore, rather difficult to ascertain precisely which capabilities the Chinese have already perfected and which they are just pursuing. Nevertheless, below we will briefly summarize the most plausible evidence referring to the Chinese hypersonics.

The most mature hypersonic weapon developed by the Chinese seems to be the DF-ZF launched atop the Dong Feng-17 (DF-17) medium-range ballistic missile (MRBM). It is an HGV of a range up to 2,500 km,[23] but it is unclear what kind of missions this weapon is supposed to execute. It was declared initially operationally capable on October 1, 2019. This missile is purportedly highly manoeuvrable and accurate against stationary targets.[24] It is also believed that an anti-ship variant of the missile is under development, but there has been no clear confirmation of this fact. Eighteen units were displayed on a military parade, but no verifiable data about production and deployment is available.

China is also believed to be working on the development of an HCM which is dubbed the Starry Sky 2 (Xing-Kong – 2). It has purportedly reached the velocity of Ma 5.5 at the altitude of 30 km during the test in 2018.[25] It is, however, unknown if this vehicle is only a technology proving craft or already a missile prototype – most probably, it is the former. So, the Chinese HCM is, in essence, an advanced technology demonstrator comparable to the American X-43A unmanned testbed, which reached Ma 9.6 at the altitude of 33.5 km in 2004.

The development of hypersonic weapons gives the Chinese a somewhat greater chance of shifting the strategic balance in their favor compared to the Russians. A more detailed argument presented below is rather theoretical and based on the assumed capabilities of the current and prospective Chinese weapons systems.

Firstly, the Chinese strategic deterrent force is much smaller than the American one. That is why, if the PRC decides to pursue an intercontinental variant of its HGV, it would matter more than a handful of novel weapons in the vast Russian arsenal. It is currently not known if the Chinese are actually working on such a weapon, despite the recent test in which an HGV was carried into orbit, and after the release, it circumnavigated the world back to China.[26] In theory, adding hypersonic weapons with better

[23] A. Panda, "Introducing the DF-17: China's Newly Tested Ballistic Missile Armed With a Hypersonic Glide Vehicle", *The Diplomat*, 28 December 2017, at https://thediplomat.com/2017/12/introducing-the-df-17-chinas-newly-tested-ballistic-missile-armed-with-a-hypersonic-glide-vehicle/, 1 March 2022.

[24] "DF-17", The Missile Threat, 2 August 2021, at https://missilethreat.csis.org/missile/df-17/, 1 March 2022.

[25] S. Stashwick, "China Tests New 'Waverider' Hypersonic Vehicle", *The Diplomat*, 9 August 2018, at https://thediplomat.com/2018/08/china-tests-new-waverider-hypersonic-vehicle/, 1 March 2022.

[26] B. Bowe, C. Hunter, "Chinese Fractional Orbital Bombardment", *Policy Brief*, no. 78 (2021), Asia-Pacific Leadership Network, 1 November 2021, at https://www.apln.network/analysis/policy-briefs/chinese-fractional-orbital-bombardment, 15 March 2022.

penetration capabilities would help ensure the balance of strategic offensive weapons. It depends, however, on the number of fielded novel weapons compared to the arsenal of traditional strategic means of delivery. As Beijing considers its strategic arsenal of less than 100 delivery systems capable of hitting the U.S. inadequate,[27] China is poised to modernize and expand its strategic deterrent forces. Consequently, it has already fielded the new road-mobile ICBMs with more ground-based missiles to be deployed in the near future. It is also determined to increase the capabilities of the strategic submarine force,[28] and designing new bombers is considered as well. This massive modernization requires generous financing, and it is doubtful if presumably costly hypersonic weapons will be the priority over matured and much cheaper systems. Thus, even if the Chinese intercontinental HGV materializes in the foreseeable future, it will not change the overall balance significantly.

Secondly, China is also expanding its capabilities to secure its mainland from a conventional strike of the U.S. forces deployed in the bases around China and on the adjacent seas. In the West, it is called the A2/AD strategy and is designed to deny the enemy the use of staging areas for such strikes by limiting the freedom of operation of the U.S. Navy and holding the U.S. military installations around China under the threat of a crippling attack. Hypersonic gliders and HCMs, even in limited quantities, may become valuable assets[29] available for this strategy, especially at greater distances. However, it is unlikely if they can significantly shift the strategic balance, mostly because they are very costly weapons that do not bring any unique capability, as has been argued above.

Summarizing the value of hypersonic weapons for China, we point at two overlapping issues. On the strategic level, hypersonic weapons may somehow contribute to the ensuring of the balance with the U.S. in terms of nuclear deterrence, but it is not critically important for that. Thus, the American territory will remain endangered by the Chinese second strike assets even without hypersonic weapons. The medium-range HGVs or the prospective HCMs will impact the regional balance, which is poised to shift somewhat in favor of the Chinese. Nevertheless, this process is rather inevitable even without hypersonic weapons. It is because the Chinese capabilities critical for the A2/AD strategy, such as satellite ISR systems, over-the-horizon (OTH) radars, long--range ballistic and cruise missiles, and attack submarines, have matured anyway. All in all, the hypersonic weapons are no game-changers by themselves, they are only part of the comprehensive effort that China has undertaken for a long time.

---

[27] G. Kulacki, *China's Nuclear Force: Modernizing from Behind*, Union of Concerned Scientists, January 2018, at https://www.ucsusa.org/sites/default/files/attach/2018/01/modernizing-from-behind.pdf, 1 March 2022.

[28] H.M. Christensen, M. Korda, "Nuclear Notebook: Chinese Nuclear Forces, 2021", *Bulletin of the Atomic Scientists*, 15 November 2021, at https://thebulletin.org/premium/2021-11/nuclear-notebook-chinese-nuclear-forces-2021/, 17 March 2022.

[29] J.A. Tirpak, "The Great Hypersonic Race", *Air & Space Forces Magazine*, 27 June 2018, at https://www.airforcemag.com/article/The-Great-Hypersonic-Race/, 1 March 2022.

3.3. The United States

The U.S. has got by far the greatest knowledge about hypersonics. It started thinking about vehicles capable of gliding from orbit at hypersonic speed as early as in the late 1950s. The first relatively mature concept was the X-20 Dyna-Soar spaceplane, abandoned in 1963. In the 1980s, the Space Transportation System was introduced, better known as the Space Shuttle. It was nothing less than a huge hypersonic gliding vehicle, which flew 133 successful missions during 30 years of service which ended in 2011. The Americans were also the first to start flight-testing scramjet engines by 2001 during NASA's Hyper-X program. However, it was a scientific endeavor, aiming at basic research on the hypersonic powered flight, not a weapons development program. The U.S. felt no urgency with the development of hypersonic weapons, the military budget was strained by more pressing issues like foreign engagements and other vast armament projects.

Currently, we can observe a rapid growth of budget expenditures related to the development of actual hypersonic weapons. There are several programs of that sort at various stages of development, representing both HGV and HCM concepts. Given the amount of knowledge, the technological skills of leading aerospace manufacturers and the massive funds allocated, we may expect the first hypersonic weapons of the boost-glide type to enter service in the U.S. armed forces in the coming years. We may also expect HGVs to be produced in relatively large quantities, so the American arsenals will most likely grow fast. HCMs will probably follow within a decade.

There are numerous hypersonic weapons programs at various stages of development in the United States; at least eight of them are listed in openly available sources.[30] The most mature American hypersonic weapon is the AGM-183A ARRW (Air-Launched Rapid Response Weapon, sometimes dubbed Arrow), the only one that has been given an official weapon designation, what clearly indicates the level of advancement of the program. It was supposed to materialize as early as 2021, but three tests conducted that year failed, what spurred some concern in the United States military and political circles. Finally, on 14 May 2022, the missile flew successfully for the first time.[31] According to current estimates,[32] which are very scarce and not confirmed, AGM-183A has a range of 1,000 km and an initial speed of Ma 7. The weapon is being developed by Lockheed Martin and generously funded by the U.S. Air Force.

The AGM-183A is a relatively small[33] missile that can be fitted with several hundred kilograms of explosives or a small nuclear device. What exactly this kind of weapon

30 *Hypersonic Weapons: Background and Issues...*

31 G. Hadley, "ARRW Flies at Hypersonic Speeds in First Successful Test", *Air & Space Forces Magazine*, 16 May 2022, at https://www.airforcemag.com/arrw-flies-at-hypersonic-speeds-in-first-successful-test/, 18 May 2022.

32 M. Episkopos, "Why the Air Force Is Struggling to Make a Hypersonic Missiles Work", The National Interest, 4 August 2021, at https://nationalinterest.org/blog/buzz/why-air-force-struggling-make-hypersonic-missiles-work-191224, 1 March 2022.

33 See for example: post #36 in: "AGM-183A ARRW", Secret Projects Forum, 20 June 2019, at https://www.secretprojects.co.uk/threads/agm-183a-arrw.30639/#post-353661, 1 March 2022.

could do much better than the existing cruise missiles or conventional ballistic missiles is uncertain. Surely, the rapid precision strike capabilities of the U.S. military will be somewhat augmented with the advent of this weapon. But is it worth the cost? Similar concern has been expressed by Air Force Secretary Frank Kendall, who said that he was *not satisfied with the degree to which we have figured out what we need for hypersonics, of what type, for what missions*.[34] Nonetheless, the U.S. Air Force expects to start producing the weapon in 2022, as funding of the first 12 pieces is enclosed in the FY 2022 budget proposal.[35]

Despite the generous investment, we do not expect that the United States will gain any significant and game-changing capability out of the development of hypersonic weapons in the foreseeable future. It refers to the abovementioned AGM-183A as well as to the HCM concept that Lockheed Martin is developing.[36] Although it is very much possible that the United States will quickly outpace China and Russia in numbers of deployed hypersonic weapons, they will remain a small part of the U.S. arsenal. Valuable, but surely not giving the U.S. any significant boost in already existing military preponderance.

4. SECURITY AND POLITICAL CONTEXT OF THE DEVELOPMENT OF HYPERSONIC WEAPONS

From the political point of view, we can see two perspectives of analyzing the impact of the development of hypersonic weapons. One refers to international security, another to the interests of nations involved in the hypersonic race, particularly their national security, but not only.

4.1. International Security

It is widely believed that the deployment of hypervelocity attack systems will contribute to the destabilization of international strategic balance due to their capabilities to stage surprise attacks. A nation that wields even limited quantities of the HGVs or HCMs may decide to venture on some kind of decapitating or debilitating strike against a perceived adversary, hence purported destabilization. This common argument is true but

[34] B. Everstine, "Kendall: USAF Needs to Reassess Role of Hypersonics", Aviation Week Network, 21 September 2021, at https://aviationweek.com/shows-events/afa-air-space-cyber-conference/kendall-usaf-needs-reassess-role-hypersonics?utm_rid=CPEN1000001539178&utm_campaign=30040&utm_medium=email&elq2=29baaeceacee4b6a8b7ceb2d658a24a5, 1 March 2022.

[35] V. Insinna, "After Latest Flight Test Failure, US Air Force Hopes to Keep First Hypersonic Missile on Track for Production", *Defence News*, 4 August 2021, at https://www.defensenews.com/air/2021/08/04/after-latest-flight-test-failure-us-air-force-hoping-to-keep-first-hypersonic-missile-on-track-for-production/, 1 March 2022.

[36] *Second Successful Flight for DARPA Hypersonic Air-Breathing Weapon Concept (HAWC)*, Defence Advanced Research Projects Agency, 4 April 2022, at https://www.darpa.mil/news-events/2022-04-05, 10 April 2022.

only to an extent, as hypersonic weapons do not create the capability to conduct such a strike – it already exists. A decapitating or disarming offensive may, in theory, be attempted with the use of existing technologies or their easily achievable derivatives. Conventional cruise missiles, submarine-launched ballistic missiles (SLBMs) fired at short to medium distances at depressed trajectories, or prospective superfast medium-range ballistic missiles with maneuverable warheads may be used for this kind of mission. Admittedly, hypersonic weapons may be somewhat more effective to execute such an attack, but the difference is not big enough to significantly reduce the risk involved. Plainly speaking, such an undertaking, although to some extent more likely to succeed with the use of hypersonic weapons than with conventional ones, would remain essentially as risky and tricky as before. Only low-flying HCMs might, in theory, significantly change the situation, but it is still premature to consider this.

A more likely destabilization effect may come from a less frequently mentioned direction. As we have already mentioned, the United States will probably deploy hypersonic weapons relatively soon and in sizable quantities. It will surely be politically momentous and invoke counteractions from the competitors, both in-kind and asymmetric. Consequently, global tensions, emotions, uncertainties, and suspicions among the global military powers will increase. This process will certainly contribute to the general arms race with all its destabilizing potential but rather as a part of the wider phenomenon.

Thus, in the foreseeable future international security as a whole will surely be impacted by the advent of hypersonic weapons. Still, this impact will be limited and will rather be a part of the already existing dangers than a quality by itself.

4.2. Russian Federation – National Security and Foreign Policy Issues

The Russian Federation's political identity is largely based on the assumption that it is destined to be a first-class world power. Globally significant military might is also believed to be necessary from the national security perspective. However, Russia is unable to sustain its own economic, social and technological development; it was obvious well before it suffered crippling sanctions following the Ukraine war of 2022. This way, Russia is deteriorating as a state, even though Moscow is still pretending to be one of the world's leading powers.

The last attribute of Russia's greatness is its military weight, particularly its nuclear arsenal. Thus, the strategic relationship is the last field where Russia might interact with the U.S. on a relatively equal basis. This purported parity with the United States is one of the main reasons why Moscow stresses the military dimension of Russo-American relations so much. Displaying the warfighting capabilities by participating in actual conflicts, conducting military provocations, and advertising highly advanced weapons is a part of this strategy destined to use the last trait of a superpower that Russia possesses to the greatest possible extent. And here come hypersonic weapons, heavily promoted for the internal and international public as the invincible unmatched technology 'made in Russia'.

In more practical terms, novel weapons may also become an important bargaining chip in the future. It is true that the arms control process seems dead and would rather not resurrect any time soon. Instead, we will witness another leg of the arms race, with hypersonic weapons as part of it. But eventually, the parties will most likely come to the table, probably with China as an equal partner. Even without profound military significance, well-developed hypersonic weapons may play some part in this political process.

4.3. People's Republic of China – National Security and Foreign Policy Issues

As for China, hypersonic weapons are somewhat important from the operational point of view in the first place, as we have argued above. However, we have to remember that their development should be understood as significant part of the overall effort to increase the warfighting potential of the state. It is not a separate process leading to acquiring totally unique game-changing capabilities. Thus, hypersonic weapons are important, but just as part of the big picture and by no means a critical element of it.

Nevertheless, another dimension of developing hypersonics in China, the political one, must be highlighted. It is generally understood that technological development is what is shaping the world to a great extent. Therefore, a nation that aspires to the global superpower status must also assume leadership in science and technology. Hence, hypersonics, like other state-of-the-art weapons systems and other most advanced technologies, is an important part of the overall Chinese development program. Moreover, it is the field of research where China seems, at least according to the news, to lead the world, allegedly surpassing America. Therefore, this is a critically important opportunity to prove that the Middle Kingdom has already emerged as a significant competitor to the U.S. in this sophisticated field. Pioneering, or at least appearing to pioneer in the novel weapons development is therefore very useful as a clear sign of the Chinese technological prowess, which is part of its overall power contributing to the rise of China's position in the world.

All in all, for China, the development of hypersonics is not only a military issue but also a matter of prestige and a valuable argument for the high international status of the country. Therefore, the political dimension of developing novel weapons seems even more important than the military considerations.

4.4. The United States – National Security and Foreign Policy Issues

As the Chinese and Russians boast of novel technologies, claiming that they have surpassed the famed American high-tech, the U.S. politicians, military experts, and political commentators eagerly take up this narrative.[37] Thus, a demand to step up funding and development of own American hypersonic weapons, which allegedly are far behind

[37] See for example: B. Everstine, "Space Force Official Says U.S. Behind China, Russia in Hypersonics", Aviation Week Network, 22 November 2021, at https://aviationweek.com/defense-space/missile-defense-weapons/space-force-official-says-us-behind-china-russia-hypersonics, 15 March 2022.

Chines or Russian equivalents, mount steadily. It is, however, a political alternative reality, we are apparently witnessing the creation of the 'hypersonic gap' concept, similar to the previous 'bomber gap' or 'missile gap' perceived in the 1950s. In fact, the Chinese and Russians are neither overtaking the U.S. significantly nor they are anywhere close to deploying militarily significant numbers of gliding maneuverable warheads for their long-range ballistic missiles. What is more, there would be no change in the effectiveness of the missile defense if such systems are deployed because – let us reiterate – it is already ineffective against sophisticated ballistic missiles with advanced penetration aids, and it will most likely remain so for the time being.

But the allegations of backwardness of the United States have their deeper political purposes, related to internal politics and vested economic interests. First of all, the 'hypersonic gap' provides politicians of all denominations with a powerful tool to assert themselves on the internal political market. It is a well-known mechanism of inflating external threats to show officials' purported decisiveness, strength, and ability to lead. It usually allows scoring points in a partisan struggle easily, so everyone tries to catch up with it. This mechanism intertwines with the interest of powerful industrial circles, interrelated with politics through well-established, well-known channels. The development and procurement of novel expensive weapons give the industry a chance for increased profits[38] and create workplaces for the constituencies of influential political figures. This will most probably happen with the hypersonic weapons as they are about to become the new industrial expansion field, making many people and companies interested in promoting their development.

And finally, the United States is compelled to develop hypersonic weapons systems to help upkeep its global leadership. Until recently, the Americans have not felt any urgency to develop such weapons because no one wielded this technology. But as the fielding of the novel systems by the adversaries is about to happen or actually have happened, the U.S. must follow suit to prove its leading position in the world.

5. CONCLUSIONS

We do not negate the fact that the hypersonic weapons possess some superb technical qualities and operational capabilities. Putting aside obviously false presentations, like the one[39] that depicts the Avangard rather as an HCM, not HGV, they are surely impressive. However, the newest technical analyses suggest that hypersonic weapons are easier to track and more vulnerable to properly tailored defensive measures than it has

[38] A. Greg, "Military-Industrial Complex Finds a Growth Market in Hypersonic Weaponry", *The Washington Post*, 21 December 2018, at https://www.washingtonpost.com/business/2018/12/21/military-industrial-complex-finds-growth-market-hypersonic-weaponry/, 10 March 2022.

[39] Ministry of Defence of the Russian Federation, "Kompleks «Avangard» s giperzvukovym planiruyushchim krylatym blokom" [Минобороны России, "Комплекс «Авангард» с гиперзвуковым планирующим крылатым блоком"], YouTube, 1 March 2018, at https://www.youtube.com/watch?v=o-5UEq32-wc, 10 March 2022.

been usually believed.[40] Multi-faceted efforts to design and field means of tracking[41] and intercepting[42] hypersonic weapons have also advanced.

Furthermore, if we look at the big picture, we notice that technical capabilities do not stand alone for the usefulness of certain weapons systems and their real significance. Every weapon is part of a wider military and political effort and should be considered within proper national and international contexts. With regard to the already existing and soon-to-be-fielded hypersonic weapons, it is not clear what unique missions they might execute. It is particularly visible in the American posture, which lacks a clear purpose for the new weapons. The price tag attached reduces their usability even more. All in all, it may even appear that the inherent shortcomings of the novel weapons will outweigh the advantages in the long run.

Therefore, the multi-faceted political role of the hypersonic weapons is more important as a driver of their development than much-hyped strategic or operational needs based on their real or purported characteristics. As we have shown, all three global powers embrace internal and international political goals in their strategies of developing hypersonics. And it is going to remain so unless some impossible to predict breakthrough in hypervelocity technology changes the strategic equation.

BIBLIOGRAPHY

"AGM-183A ARRW", post #36 on Secret Projects Forum, 20 June 2019, at https://www.secretprojects.co.uk/threads/agm-183a-arrw.30639/#post-353661.

"AS-15 Kent (Kh-55 Granat)", Missile Defense Advocacy Alliance, June 2017, at https://missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/russia/as-15-kent-kh-55-granat/.

Bugos S., Reif K., "Understanding Hypersonic Weapons: Managing the Allure and the Risks", Arms Control Association Report, September 2021, at https://www.armscontrol.org/reports/2021/understanding-hypersonic-weapons.

Bowe B., Hunter C., "Chinese Fractional Orbital Bombardment", *Policy Brief*, no. 78, Asia-Pacific Leadership Network, 1 November 2021, at https://www.apln.network/analysis/policy-briefs/chinese-fractional-orbital-bombardment.

Bureau of Arms Control, Verification and Compliance, "New START Treaty Aggregate Numbers of Strategic Offensive Arms", U.S. Department of State, 1 September 2021, at

[40] T. Karako, M. Dahlgren, "Complex Air Defense: Countering the Hypersonic Missile Threat", Center for Strategic & International Studies, 7 February 2022, at https://www.csis.org/analysis/complex-air-defense-countering-hypersonic-missile-threat, 11 March 2022.

[41] For example: N. Strout, "New Hypersonic Missile-Tracking Satellites Pass Critical Design Review", *Defense News*, 21 December 2021, at https://www.defensenews.com/battlefield-tech/space/2021/12/21/new-hypersonic-missile-tracking-satellites-pass-critical-design-review/, 15 March 2022.

[42] S. Trimble, G. Warwick, "DARPA Reveals Key Piece of Future Hypersonic Interceptor", Aviation Week Network, 17 August 2021, at https://aviationweek.com/defense-space/missile-defense-weapons/darpa-reveals-key-piece-future-hypersonic-interceptor, 15 March 2022.

https://www.state.gov/wp-content/uploads/2021/09/09-28-2021-September-NST-FACTSHEET-draft-Copy.pdf.

Butowski P., "Russia Creates Its First Hypersonic Strike Regiment", Aviation Week Network, 20 January 2022, at https://aviationweek.com/defense-space/aircraft-propulsion/russia-creates-its-first-hypersonic-strike-regiment.

Christensen H.M., Korda M., "Nuclear Notebook: Chinese Nuclear Forces, 2021", *Bulletin of the Atomic Scientists*, 15 November 2021, at https://thebulletin.org/premium/2021-11/nuclear-notebook-chinese-nuclear-forces-2021/.

Czajkowski M., "Hypersonic Missiles – a Political Multipurpose Weapon", *Analiza Zakładu Bezpieczeństwa Narodowego UJ* 2019, no. 4(43) (2019), at https://zbn.inp.uj.edu.pl/documents/92718966/141790394/Czajkowski+-+Analiza1/1cfa6113-361a-4ef8-b3d9-53bc659c6cd1.

Czajkowski M., "Hypersonic Hype Revisited", *Analiza KBN*, no. 14(94) (2021), at https://zbn.inp.uj.edu.pl/documents/92718966/141790394/Analiza94-Czajkowski-1/5f19cf91-7193-49c8-a11f-0fdde811be66.

Czajkowski M., "Ballistic Missile Defence – Technology, Effectiveness and Organization – Key Issues", *Politeja*, vol. 14, no. 5(50) (2017), pp. 227-262, https://doi.org/10.12797/Politeja.14.2017.50.11.

"DF-17", The Missile Threat, 2 August 2021, at https://missilethreat.csis.org/missile/df-17/.

"DRDO Successfully Flight Tests Hypersonic Technology Demonstrator Vehicle", Press Information Bureau Government of India Ministry of Defence, 7 September, 2020, at https://pib.gov.in/Pressreleaseshare.aspx?PRID=1651956.

Episkopos M., "Russia's Hypersonic Tsirkon Missile: Just How Dangerous Is It?", The National Interest, 20 July 2021, at https://nationalinterest.org/blog/buzz/russia%E2%80%99s%C2%A0hypersonic%C2%A0tsirkon%C2%A0missile-just-how-dangerous-it-190004.

Episkopos M., "Why the Air Force Is Struggling to Make a Hypersonic Missiles Work", The National Interest, 4 August 2021, at https://nationalinterest.org/blog/buzz/why-air-force-struggling-make-hypersonic-missiles-work-191224.

Everstine B., "Kendall: USAF Needs to Reassess Role of Hypersonics", Aviation Week Network, 21 September 2021, at https://aviationweek.com/shows-events/afa-air-space-cyber-conference/kendall-usaf-needs-reassess-role-hypersonics?utm_rid=CPEN1000001539178&utm_campaign=30040&utm_medium=email&elq2=29baaeceacee4b6a8b7ceb2d658a24a5.

Everstine B., "Space Force Official Says U.S. Behind China, Russia in Hypersonics", Aviation Week Network, 22 November 2021, at https://aviationweek.com/defense-space/missile-defense-weapons/space-force-official-says-us-behind-china-russia-hypersonics.

Greg A., "Military-Industrial Complex Finds a Growth Market in Hypersonic Weaponry", *The Washington Post*, 21 December 2018, at https://www.washingtonpost.com/business/2018/12/21/military-industrial-complex-finds-growth-market-hypersonic-weaponry/.

Hadley G., "ARRW Flies at Hypersonic Speeds in First Successful Test", *Air & Space Forces Magazine*, 16 May 2022, at https://www.airforcemag.com/arrw-flies-at-hypersonic-speeds-in-first-successful-test/.

Hypersonic Weapons: Background and Issues for Congress, Congressional Research Service, 19 October 2021, at https://sgp.fas.org/crs/weapons/R45811.pdf.

Insinna V., "After Latest Flight Test Failure, US Air Force Hopes to Keep First Hypersonic Missile on Track for Production", *Defence News*, 4 August 2021, at https://www.defensenews.com/air/2021/08/04/after-latest-flight-test-failure-us-air-force-hoping-to-keep-first-hypersonic-missile-on-track-for-production/.

Karako T., Dahlgren M., "Complex Air Defense: Countering the Hypersonic Missile Threat", Center for Strategic & International Studies, 7 February 2022, at https://www.csis.org/analysis/complex-air-defense-countering-hypersonic-missile-threat.

Kaushal S., "Putting the Russian Hypersonic Threat in Perspective", RUSI Commentary, 28 September 2021, at https://www.rusi.org/explore-our-research/publications/commentary/putting-russian-hypersonic-threat-perspective.

"Kh-47M2 Kinzhal", Military-Today.com, at http://www.military-today.com/missiles/kh_47m2_kinzhal.htm.

Kulacki G., *China's Nuclear Force: Modernizing from Behind*, Union of Concerned Scientists, January 2018, at https://www.ucsusa.org/sites/default/files/attach/2018/01/modernizing-from-behind.pdf.

Kunertova D., "Weaponized and Overhyped: Hypersonic Technology", *CSS Analyses in Security Policy*, no. 285, June 2021, at https://css.ethz.ch/content/dam/ethz/special-interest/gess/cis/center-for-securities-studies/pdfs/CSSAnalyse285-EN.pdf.

Luzin P., "Russia's Race for Hypersonic Weapons", *Eurasia Daily Monitor*, vol. 18, no. 170 (2021), at https://jamestown.org/program/russias-race-for-hypersonic-weapons/.

Mahshie A., "Hypersonics Defense", *Air & Space Forces Magazine*, 19 January 2022, at https://www.airforcemag.com/article/hypersonics-defense/.

Ministry of Defence of the Russian Federation, "Kompleks «Avangard» s giperzvukovym planiruyushchim krylatym blokom" [Минобороны России, "Комплекс «Авангард» с гиперзвуковым планирующим крылатым блоком"], YouTube, 1 March 2018, at https://www.youtube.com/watch?v=o-5UEq32-wc.

Panda A., "Introducing the DF-17: China's Newly Tested Ballistic Missile Armed With a Hypersonic Glide Vehicle", *The Diplomat*, 28 December 2017, at https://thediplomat.com/2017/12/introducing-the-df-17-chinas-newly-tested-ballistic-missile-armed-with-a-hypersonic-glide-vehicle/.

Podvig P., "Deployment of Avangard Continues in Dombarovskiy", Russian Strategic Nuclear Forces, 16 December 2020, at https://russianforces.org/blog/2020/12/deployment_of_avangard_continu.shtml.

Second Successful Flight for DARPA Hypersonic Air-Breathing Weapon Concept (HAWC), Defence Advanced Research Projects Agency, 5 April 2022, at https://www.darpa.mil/news-events/2022-04-05.

Shim E., "Japan to Develop Hypersonic Missile for »Defense Purposes«", United Press International, 19 September 2018, at https://www.upi.com/Top_News/World-News/2018/09/19/Japan-to-develop-hypersonic-missile-for-defense-purposes/9911537361251/.

Smith R.J., "Hypersonic Missiles Are Unstoppable. And They're Starting a New Global Arms Race", *The New York Times Magazine*, 19 June 2019, at https://www.nytimes.com/2019/06/19/magazine/hypersonic-missiles.html.

Stashwick S., "China Tests New 'Waverider' Hypersonic Vehicle", *The Diplomat*, 9 August 2018, at https://thediplomat.com/2018/08/china-tests-new-waverider-hypersonic-vehicle/.

Strout N., "New Hypersonic Missile-Tracking Satellites Pass Critical Design Review", *Defense News*, 21 December 2021, at https://www.defensenews.com/battlefield-tech/space/2021/12/21/new-hypersonic-missile-tracking-satellites-pass-critical-design-review/.

Tirpak J.A., "The Great Hypersonic Race", *Air & Space Forces Magazine*, 27 June 2018, at https://www.airforcemag.com/article/The-Great-Hypersonic-Race/.

Tracy C.L., Wright D., "Modeling the Performance of Hypersonic Boost-Glide Missiles". *Science & Global Security*, vol. 28, no. 3 (2020), pp. 135-170, https://doi.org/10.1080/08929882.2020.1864945.

Trimble S., "U.S. Hypersonic Programs Look to Recover Momentum in 2022", Aviation Week Network, 16 December 2021, at https://aviationweek.com/defense-space/missile-defense-weapons/us-hypersonic-programs-look-recover-momentum-2022.

Trimble S., Warwick G., "DARPA Reveals Key Piece of Future Hypersonic Interceptor", Aviation Week Network, 17 August 2021, at https://aviationweek.com/defense-space/missile-defense-weapons/darpa-reveals-key-piece-future-hypersonic-interceptor.

Marek CZAJKOWSKI – graduated from International Relations at Jagiellonian University. Professor at the Institute of Political Sciences and International Relations, Jagiellonian University. The main fields of scientific interest are International Security, Strategic Studies, and Space Security. Important books: *Russian Security Policy in Europe*, *Missile Defence in International Relations*, and *Outer Space in the United States National Security Strategy*.