A Modern Day Arms Race:
HYPERSONIC WEAPONS

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THE ABILITY FOR HYPERSONIC WEAPONS TO EVADE MOST DEFENSE SYSTEMS AND CARRY NUCLEAR WARHEADS, COUPLED WITH GAPS IN TODAY'S ARMISTICES, PLACE THEM AT THE FOREFRONT OF THE GLOBAL ARMS RACE.

Hypersonic weaponry is one of the most disruptive technologies in modern defense, called a "game-changer" and "destabilizing technology" by industry experts. We recognize that this is a controversial, sensitive, and potentially polarizing topic for multiple reasons, especially given the ongoing war in Ukraine. Yet, given the significant resources governments are committing to hypersonic research and innovation, we felt it would be valuable to provide a brief, fact-based review of hypersonic technology, its history, and the potential implications from both geopolitical and industry standpoints. Our sole intent is to provide an educational overview.

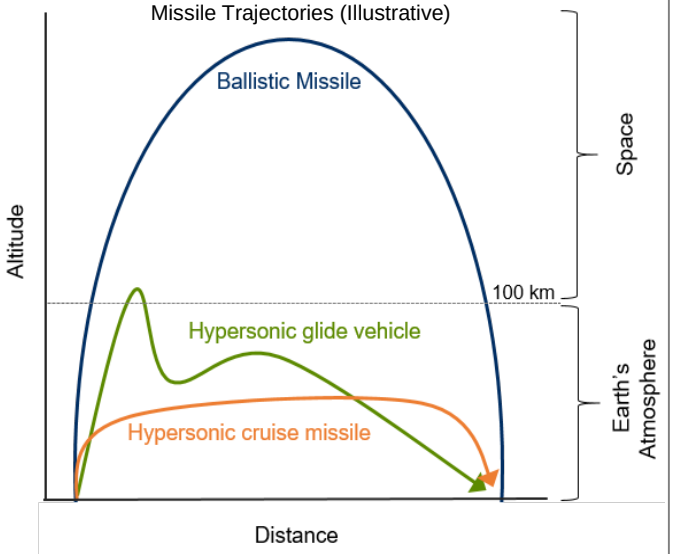
Russia allegedly fired the first hypersonic missile used in war on March 18, drawing long overdue attention to this significant technology. The ability for hypersonic weapons to evade most defense systems and carry nuclear warheads, coupled with gaps in today's armistices, place them at the forefront of the global arms race. Nations with sophisticated hypersonic technology will likely gain material military advantages in the geopolitical theatre, and major defense forces around the world are investing heavily to bolster their capabilities.

INNOVATIVE, EVASIVE, AND NEARLY UNSTOPPABLE

Designed to travel at least five times the speed of sound (with some capable of traveling above 20 times, or 4.3 miles per second), a hypersonic missile can cross the Pacific Ocean in less than 30 minutes and detonate a force over four times as strong as TNT. It can also be steered during flight, making its trajectory highly unpredictable versus a traditional missile. The maneuverability, speed, and extensive range of hypersonic weapons make them nearly impossible to defend against with current systems and technology.

Hypersonic weapons come in two varieties, both with elusive and non-traditional flight patterns (**Chart 1**). Hypersonic glide vehicles launch from rockets and glide to their targets like stones skipping downstream. Hypersonic cruise missiles use air-breathing engines called "scramjets" to fly mostly horizontally at extremely low altitudes. With a majority of the trip within Earth's atmosphere, hypersonic weapons must withstand incredible heat, wind, and other environmental factors to maintain accuracy. Mimicking these extreme flight conditions during testing is one of the main obstacles to developing hypersonics.

Chart 1. Below the Radar, Off the Grid
Missile Trajectories (Illustrative)



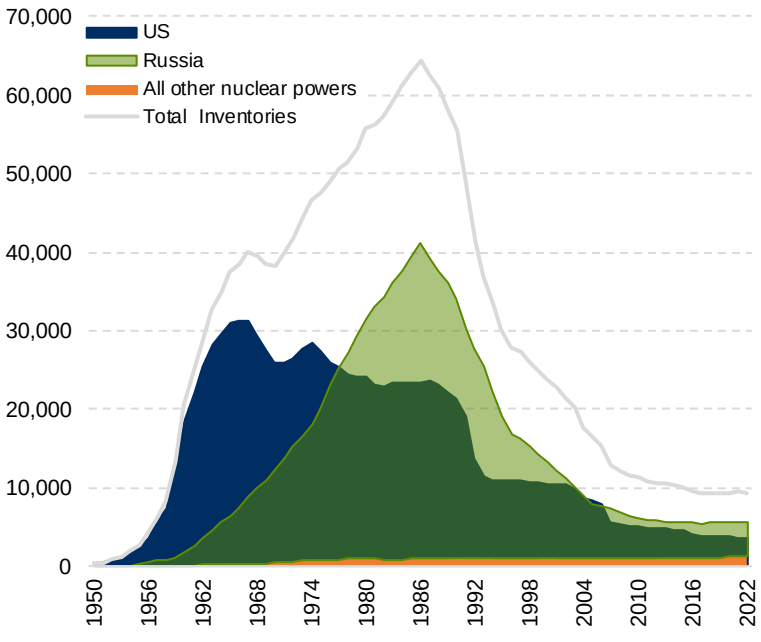
Source: Sander Ruben Aarten, Militaire Spectator

Rising Threat with Heavy Strategic Impact

Aside from the staggering science, the ability for hypersonic weapons to carry nuclear warheads brings forth extensive implications for mutual assured destruction (MAD) – the bedrock doctrine where the concept of total nuclear annihilation propagates military deterrence. Two key factors are pushing the boundaries of MAD and driving heavy investments into hypersonics. The result? A modern day arms race.

Firstly, warhead inventories have begun to pick up for the first time in decades and experts believe retired weapons are being replaced with ready-to-use stockpiles. Nuclear warhead inventories systematically declined from over 64,000 in 1985 to less than 10,000 today, as estimated by the Federation of American Scientists (**Chart 2**), but superpowers around the world are beginning to add to their arsenals. Secondly, the only active treaty governing the two largest nuclear powers – US and Russia – is the New Strategic Arms Reduction Treaty (or "New START") and it does not explicitly restrict hypersonic missiles from carrying nuclear weapons. This gap provides room for the US to improve its technological capabilities and defenses, as well as increase leverage in future diplomatic negotiations.

Chart 2. Estimated Ready-to-use Nuclear Warhead Inventories
(1950 - 2022)



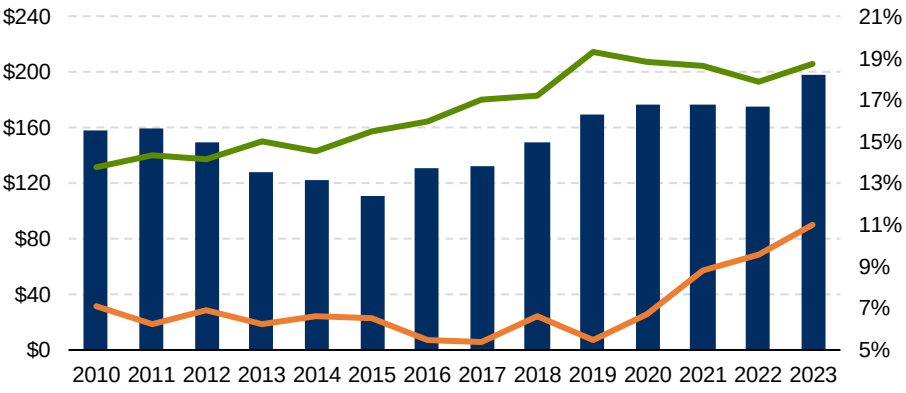
Source: Federation of American Scientists, 2022

Multi-National Vested Interest with Few Capable Private Players

Mastering hypersonic missile technology is a geopolitical goal long in the making. The US and China have been pursuing hypersonic weapons technology since the 1950s, as has Russia since the 1980s. The US put its program on hold just over a decade ago, but soon thereafter made it a top priority with bipartisan support as threat levels started to rise. Over 20 other countries, including France, Australia, Germany, India, and others, also have active hypersonic research programs but very few have made significant defense outlays in recent years.

In the US, Raytheon and Lockheed Martin are leading contractors for hypersonic technology and related systems within missiles and space end markets. These areas made up over a third of sales for both companies and represent growing portions of defense budgets across administrations **(Chart 3).** Boeing, Northrop Grumman, and L3Harris are also utilizing their expertise in aircrafts, sensors, and components in hopes of growing footholds in these markets. The Pentagon's 2023 budget request for hypersonic research is $4.7 billion[1], with a 25% compounded annual growth rate since 2014[2], making it one of the fastest growing areas in defense spending. It is expected that broader development of advanced technology will level the playing field between nations in hopes of improved diplomatic stability in the years ahead. Accordingly, companies with strong fundamentals, market-leading intellectual capital, and solid, visionary management teams have long runways of potential growth opportunities.

Chart 3. US Department of Defense Procurement Request



Source: Under Secretary of Defense. Note: Defense Procurement excludes Mission Support Activities.

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[1] Source: Bloomberg.com (https://www.bloomberg.com/news/articles/2022-03-28/pentagon-s-773-billion-budget-focuses-on-nuclear-weapons-r-d)
[2] Source: Deloitte report, "The Rise of Hypersonics: Hypersonic Weapons and Flight Breaking New Barriers," March 2020.
[3] As of 03/31/22

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