Mach Diplomacy: Hypersonics and Global Power

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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STS Research Paper

Seconds to Impact

You are an American sailor deployed in the south China sea on one of the most advanced destroyers in the world. Tensions between China and the United States are at an all-time peak. From the ship's bridge, you observe a faint white streak crossing over the horizon. Sensors alert you to its presence, indicating that it is on a trajectory towards your vessel at a speed of 3806 mph. Fourteen seconds after first detecting it, it impacts. What just hit you was a hypersonic cruise missile (HCM), which is part of a newly emerging category of hypersonic offensive weapons (Van Wie, 2024). This scenario offers insight into what could arise in a world where hypersonic technologies have reshaped warfare as we know it.

Such a scenario prompts the question: how does the development of hypersonic technologies impact international stability and power dynamics? Hypersonic weapons depend on intricate and precise components that must seamlessly integrate to function effectively (Sayler, 2024). Therefore, there are critical infrastructure elements involved in the development of hypersonics. American Sociologists Susan Leigh Star's *Ethnography of Infrastructure* argues that infrastructure is not merely technical, but deeply social. Applying this sociotechnical concept to hypersonics, it becomes clear that these technologies are not merely tools of warfare, but are embedded within complex political and cultural networks.

This research paper focuses on the United States, Russia, and China as the primary actors in the development of hypersonic technologies. It examines each nation's past, present, and future hypersonic programs, analyzing the military budget and their financial commitment to it. Public opinion data from Gallup Analytics offers valuable insights into the general attitudes

toward each country. This study also investigates if there is an increased “first strike” tendency from published military exercises. Global peace indices provided by the Institute for Economics & Peace highlights instability and tension. Lastly, public speeches from each world leader referencing hypersonics offers insight into how hypersonics are framed within national security narratives.

What are Hypersonics

An object is classified as “hypersonic” when it exceeds five times the speed of sound (Schmidt, 2024). Vehicles capable of reaching these velocities have been around for 60 years, dating back to the German V-2. More modern examples include reentry capsules, the Space Shuttle, and SpaceX’s Falcon 9 (Van Wie, 2024). What sets today’s advancements apart is the emergence of offensive hypersonic weapons, positioning them at the forefront of aerospace technology.

Offensive hypersonic weapons are split into two subcategories: Hypersonic Glide Vehicles (HGVs) and Hypersonic Cruise Missiles (HCMs) (Van Wie, 2024). HGVs reach orbital/suborbital altitudes with a conventional rocket before relying on gravity and its aerodynamic design to accelerate to hypersonic speeds while HCMs are accelerated to Mach 5 using air-breathing engines such as the scramjet (Sayler, 2024). However, both HCMs and HCMs are capable of maneuvering. This maneuvering capability, coupled with their low-altitude flight, presents significant challenges in detecting them (Sayler, 2024).

Figure 1 illustrates the difference between an HGV and a convectional ICBM trajectory. One of the primary detection methods is radar. However, as shown in the figure, the curvature of

the Earth limits radar's ability to detect any weapon below a certain altitude, requiring it to be much closer before detection compared to higher-altitude trajectories.

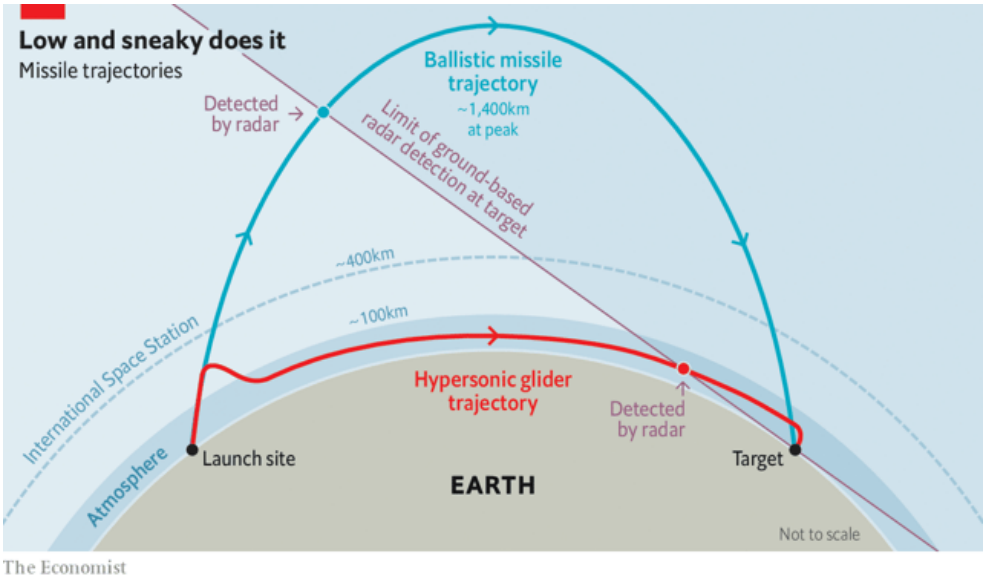

Figure 1. Missile Trajectories (The Economist, 2019)

HCMs and HGVs experience severe aerothermodynamic effects, upwards of up to 2200K (Smith, 2021). Consequently, advanced materials such as titanium-matrix composites, fiber composites, or carbon-carbon composites are essential for ensuring durability and longevity for any hypersonic vehicle (Bertin & Cummings, 2003). Such technical complexity escalates the cost of deploying hypersonic weapons. For example, the Army's proposed HGV is estimated to cost $41 million per unit (Feickert, 2024). However, as history has shown, costs of groundbreaking technologies typically decrease over time.

Hypersonics and Infrastructure

As aforementioned, the hypersonic network is a highly delicate piece of infrastructure. American sociologist Susan Leigh Star explores the interconnectedness of infrastructure with social practices and communities, and how infrastructure is shapes and is shaped by everyday life (Star, 1999). Infrastructure involved people, practices, and the community. Extrapolating from this point of view, "people" would be world leaders, "practices" would be foreign policies, and "community" would be the world stage. Additionally, Star shows that infrastructure shows at least one of the following: embeddedness, transparency, reach/scope, learned as a part of membership, links with conventions of practice, embodiment of standard, built on an installed base, visible upon breakdown, and fixed in modular increments.

The military industrial complex is the relationship between the United States military and its industries that supply it (Bledsoe, 2025). This relationship is usually mutually beneficial, as industry gets awarded contracts to keep them afloat, and the military acquires new pieces of advanced technology. However, during Eisenhower's farewell speech, he warned against the establishment of the military industrial complex, cautioning that its influence should shape national policies and priorities (National Archives, 2021). His concerns appear well-founded, as evidenced by the massive U.S. military budget and the $70 million defense contractors spent on lobbying in 2023 alone (Schumer, 2023). The military industrial complex illustrates Star's idea of embeddedness, where she states that "infrastructure is sunk into and inside of other structures, social arrangements, and technologies" (Star, 1999). The military industrial complex is embedded in government policies, the economy, and even shapes academic research. The development of hypersonic weapons is deeply intertwined with the military industrial complex, as these weapons did not emerge from pure isolation. They are a product of over half a century of defense spending, government and industry partnerships, and foreign policies.

Star also notes that infrastructure is most visible when it breaks down. Missile detection systems that once brought a sense of security are exposed the moment they fail. As HGVs and HCMs primary advantage is their ability to evade traditional missile defense systems, the exposed vulnerability heightens global instability by increasing uncertainty and reducing trust among world powers. This is also fostered by the lack of transparency from world powers through their classified projects, further aiding the global sentiment of mistrust.

Hypersonics in the World Stage

The development of hypersonic technologies undermines international stability and has disrupted Western dominance, shifting power towards the East. The primary drivers of hypersonics are the United States, Russia, and China. Russian and Chinese leadership have highlighted that their pursuit of hypersonics is in direct response to the expansion of the United States military infrastructure into their regional interests. Through publicized speeches, military exercises, and peace indices, hypersonic weapons were found to be a response and driver of instability, aiding in arms race dynamics.

Russian President Vladimir Putin has been shown on various occasions to openly discuss his support for hypersonics. In a 2022 public address, Putin stated that Russia's Orshenik hypersonic ballistic missile test was conducted as a direct response to the deployment of American long-range weapons in Ukraine (Statement by the President of the Russian Federation, 2022). This shows that Putin is not afraid to escalate military actions in direct response to Western involvement. Additionally, it also underscores Russia's willingness to leverage its hypersonic capabilities as both a deterrent and a demonstration of power. One day after his public address, Putin held a meeting with military officials and members who fuel Russia's military-industrial complex where he congratulated them on the Orshenik system (Meeting with

the Defense Ministry Leadership, Representatives of the Military-Industrial Complex and Missile System Developers, 2022). During this meeting, Putin said that developing hypersonic weapons holds critical importance for Russia. Furthermore, he states that no one else has such weapons yet and there's "no means of countering such missiles", supporting the idea that Russia is a key innovator. Putin's remarks not only highlight Russia's pride in achieving a technological advantage, but also demonstrate how hypersonic weapons have become infrastructural symbols of geopolitical power. Putin is sending a message to his citizens and the international stage about Russia's renewed military capability.

Recently, Putin has become more explicit in his accusations and direct in assigning blame. In 2024 he held a press conference following his visit to Astana, where a reporter asked him if the previous systems of strategic stability, such as START-3 or INF, could be revived or if new agreements should be created (Answers to Russian Media Questions, 2024). Putin responded by saying that it is the United States that has undermined international stability by dismantling the "fundamental documents" that upheld it. He continues to say that they were "forced" to respond to these actions and had to develop weapons to overcome the missile defense systems that were in place in the United States (Answers to Russian Media Questions, 2024). Such blame-shifting language reinforces the idea that hypersonic weapon development is both a consequence and a driver of global instability. It is an action-reaction cycle like the Cold War arms races and the fact that Russia says they were "forced" implies that without hypersonics, their geopolitical standing would have been undermined by the West.

Another adversarial nation advancing hypersonic technology is China. On May 28th, 2021, Chinese President Xi Jinping gave a speech on the status of science and technology, in which he states that China is at the "forefront in hypersonic weapons." (Wang, 2022). He later

goes on to highlight Chinese independent innovation, expressing his desire for technological self-sufficiency. Later in the summer of 2021, China conducted a historic hypersonic missile test, marking the first time a hypersonic weapon traveled around the Earth fully before reentry (Thai News Service, 2021). By demonstrating the ability to launch a missile into orbit, China effectively has introduced a new level of complexity to missile defense systems. These systems are something that The Chinese government is deeply wary about, especially U.S. missile defense systems. In fact, they view it as a direct challenge to its nuclear deterrent credibility (Lora Saalman et al., 2017). If the United States missile defenses can shoot down North Korean ICBMs, then they could shoot down ICBMs launched from China. This has caused China to assume a “worst-case scenario”, forcing them to integrate hypersonic weapons into their arsenal (Lora Saalman et al., 2017). The development of hypersonic weapons allows for the swift and accurate delivery of conventional or nuclear payloads. Consistent with Star’s concept of relational infrastructure, China’s pursuit of hypersonic weaponry is a direct response to the expansion of U.S. missile defense systems in the Asia-Pacific region, reflecting China's intention to maintain its regional strategic influence. In this context, hypersonics function as both technological systems and political instruments.

Top United States military officials have identified strategic implications that access to hypersonic weapons have. In 2023, Retired Air Force general Glen D. VanHerck testified before the Senate Armed Services Committee, in which he said that hypersonics are “extremely difficult to detect and counter...” (David Vergun, 2023). VanHerck emphasizes a significant shortcoming of the United States, stating that it stems from "our inability to change at the pace required by the changing strategic environment" (David Vergun, 2023). This notion, that the United States is slow in adapting to changes, extends beyond VanHerck’s observations. 11th Vice Chairman of

the Joint Chiefs of Staff, General John E. Hyten has also been critical about the United States' pace in hypersonic research. Hyten highlights the HGV-1 and HGV-2 tests, where he says “we instituted muli-year studies into the failure process and then canceled the programs. That’s not how you go fast.” (Missile Defense Advocacy Alliance, 2020). The United States has long been the dominant global force, however as observed by the key concerns from top Air Force generals, the delay in adapting key hypersonic technologies may leave the United States vulnerable. Playing "catch-up" is never enjoyable, especially when falling too far behind could put millions of lives at risk.

It is evident that Chinese and Russian leadership have highlighted the expansion of the United States military, specifically the improvement of missile defense systems, as a reason for investing in and improving their hypersonics. This highlights the fact that hypersonic weapons are embedded within a broader military infrastructure that remains largely invisible until moments of high geopolitical tension. Their development gains visibility because they disrupt the established balance of power, showing Star’s idea that infrastructure becomes “visible when broken.” (Star, 1999). Additionally, the United States’ missile defense systems function as an infrastructural barrier which limits the strategic value of Chinese and Russian hypersonics. Consequently, these two adversarial nations further seek to improve them and render existing U.S. defense obsolete. This illustrates that infrastructure is relational, not static. What serves as a protective system for one nation is perceived as a threat by another, creating a cycle of escalation. Additionally, Star highlights that infrastructure is deeply embedded in historical and political contexts (Star, 1999). The Cold War arms race established a precedent for competitive military development, and today’s hypersonics reflect a continuation of that logic (Perlo-Freeman, n.d.). Hypersonics are seen as “unstoppable”, in fact, President Donald Trump has said

that the United States has access to a “super-duper missile” (Browne & Starr, 2020). This mirrors the historical narrative of technological supremacy, backing the role of hypersonics not just as military assets, but as symbols of geopolitical dominance. However, while Trumps statement highlights a sense of national pride, him using the word “super-duper” reflects the tendency to boast without technical expertise.

In recent years, the ties between Russia and China have strengthened significantly. The approval of China’s leadership from Russian citizens rose from 36% in 2019 to 70% in 2024 (Gallup Analytics, 2024). In the same time frame, Russian citizen’s approval of U.S. leadership declined from 11% to 6% (Gallup Analytics, 2024). The deepening Sino-Russian relationship poses a direct challenge to the United States’ influence in strategic regions. Western perceptions of China and Russia have also worsened as their military advancements continue to raise security concerns. Western approval of Chinese leadership declined from 22% in 2018 to 13% in 2024 and the United States’ approval of Russian leadership fell from 16% in 2021 to 8% in 2024 (Gallup Analytics, 2024). As hypersonics have been established as a tool of deterrence, this makes diplomatic negotiations through arms limitation treaties increasingly difficult. Moreover, the global peace indices of the United States and Russia have risen, indicating instability. In 2020, the United States obtained a GPI of 2.307 while Russia had one of 3.049, In 2024, however, these GPIs are 2.622 and 3.249, respectively (Institute for Economics & Peace, 2024). The Global Peace Index uses 23 indicators to measure peace across social safety, domestic and international conflict, and militarization (Institute for Economics & Peace, 2024). The deterioration of scores over the years suggests an increase in geopolitical instability.

There have been several weapons exercises conducted by Western powers to explore the possible effects that hypersonic weapons have. A 2019 tabletop exercise involving

representatives from government, military, and independent experts found that a key issue with hypersonics is the ambiguity they present (Borrie & Porras, 2019). Such ambiguity arises from hypersonic weapons blurring traditional distinctions between conventional and nuclear payloads, and when prompted by short decision-making times, it leads to a "use it or lose it" way of thinking (Borrie & Porras, 2019). A key component in infrastructure is that it is learned as a part of membership, where understanding and operating within a system requires specialized knowledge (Star, 1999). The difficulty in responding to hypersonic threats is that they do not fit into traditional military frameworks, rather they are key disruptors to it. As a consequence, defense officials develop new strategies to deal with them, bolstering the perception that hypersonic technologies introduce instability because existing systems, such as missile defense, are not structured to handle them effectively.

Concluding Remarks

The limitations of this project stem from the little use of hypersonics in actual warfare. Only Russia has used offensive hypersonics, specifically a Kh-47 ballistic missile, which was only prompted due to their special military operation in Ukraine (David, 2023). In addition, no hypersonic cruise missile has yet been used on the battlefield, making it challenging to obtain empirical data which suggests a clear conclusion. While publicized speeches from foreign leaders provides general attitudes towards this issue, it remains uncertain whether their attitudes align with their words.

In conclusion, this paper demonstrates that the development of hypersonic technologies has and will continue to destabilize international security. They underscore the need to rethink traditional defense strategies and are as much a product of reactive defense policies as they are catalysts for possible arms races. The development of hypersonics shows how new technologies

reflect and reshape political tensions, which end up producing instability by exposing the vulnerabilities of existing defense systems. It is vital that the global community addresses the integration of hypersonic weapons into conventional national security strategies. Through improvement in payload detection to reduce their ambiguous payload nature, or robust missile defense systems that render a lot of them ineffective, if no action is taken, the risks associated with hypersonic proliferation will only escalate.

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