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This research study explores the major strategic and operational implications these weapons pose to the U.S., and shows they will forever alter the character of war by reshaping the concept of strategic deterrence, broadening the operational level of war, and transforming warfighting in general. Observation indicates hypersonic weapons will be a difficult technology to develop, but have the potential to create a long-term competitive advantage. The assessments provide evidence the U.S. hyperwar strategy should include elevated sensors, technologies to preserve critical decision space for national leadership, activities aimed to avoid escalation, arms control mechanisms, and a move towards defining the hyper level of war.

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**HYPERSONIC WARFARE: IS THE U.S. READY?**

by

**Jon M. Snyder**

*Lieutenant Colonel, United States Air Force*

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**A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning and Strategy. The contents of this paper reflect my own personal views and are not necessarily endorsed by the Joint Forces Staff College or the Department of Defense.**

**This paper is entirely my own work except as documented in footnotes.**


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**26 May 2020**

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**Director, Joint Advanced Warfighting School**

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## **Abstract**

Hypersonic weapons represent a new frontier in modern warfare, however several problems related to the U.S. pursuit of these weapons were identified. This research study explores the major strategic and operational implications these weapons pose to the United States, and shows they will forever alter the character of war by reshaping the concept of strategic deterrence, broadening the operational level of war, and transforming warfighting in general. The author defines this altered character of war as *hyperwar*, and illustrates several key aspects of this concept. Observation indicates hypersonic weapons will be an extremely difficult technology to develop, but have the potential to create a long-term competitive advantage. The assessments provide clear evidence the U.S. hyperwar strategy should include elevated sensors, technologies to preserve critical decision space for national leadership and procedures to reduce strategic attack uncertainties, activities aimed to avoid escalation, arms control mechanisms, and a move towards defining the hyper level of war.

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## Chapter 1:

### Introduction

Hypersonic weapons represent a new frontier in modern warfare. China, Russia, and the United States will soon be armed with missiles able to travel thousands of miles in excess of five times the speed of sound, capable of maneuvering to avoid enemy defenses in the upper atmosphere, and precisely striking a target from any direction with great accuracy. Unlike current intercontinental ballistic missiles (ICBMs) that also travel at hypersonic speeds, the new breed of missiles under development act like cruise missiles, combining global range, low altitude, extreme speed, maneuverability, and precision in a way that negates any existing anti-missile defense capability to detect or track them.<sup>1</sup> General John E. Hyten, commander of United States Strategic Command, informed the Senate Armed Services Committee in March 2018, that besides the U.S. nuclear deterrent capability, “We do not have any defense that could deny the employment of such a weapon against us.”<sup>2</sup>

Recent successful Russian and Chinese hypersonic weapons tests led the United States to pursue an aggressive plan to close the perceived capabilities gap. The FY2019 National Defense Authorization Act (NDAA) called for accelerated development of hypersonic weapons. The U.S. Department of Defense (DoD) requested \$1.67 billion for hypersonic weapons development in its FY2020 proposed budget, more than double the FY2019 allocation, and plans to spend \$7.1 billion over the next five-years.<sup>3</sup> “I’m sorry for everybody out there who champions some other

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<sup>1</sup> Congressional Research Service, *Hypersonic Weapons: Background and Issues for Congress*, by Helley M. Saylor, July 11, 2019 (Washington, DC: Government Printing Office, 2019), 2.

<sup>2</sup> Testimony of John E. Hyten, Committee on Armed Services, *Hearing on United States Strategic Command in Review of the Defense Authorization Request for Fiscal Year 2019 and the Future Years Defense Program*, 115<sup>th</sup> Cong., 2<sup>nd</sup> sess., March 20, 2018, 14.

<sup>3</sup> Congressional Research Service, *Hypersonic Weapons: Background and Issues for Congress*, 7-8.

high priority, some technical thing,” stated Michael Griffin, the Under Secretary of Defense for Research and Engineering, “it’s not that I disagree with those, but there has to be a first, and hypersonics is [sic] my first.”<sup>4</sup>

While the United States is racing to develop and field this emerging technology, many security experts are concerned that hypersonic weapons threaten strategic security.<sup>5</sup> The ability of these weapons to travel between one and five miles per second, their maneuverability, and their low altitude flight make states vulnerable to surprise attack. Problems with timely detection related to an unpredictable flight path shortens reaction time for any timely response for decision-makers.<sup>6</sup> Warhead ambiguity also could result in miscalculation and immediate escalation, even if the target was not located within a country’s borders. As a result, several strategic security experts are pushing for arms control initiatives and bans on testing of hypersonic weapons.<sup>7</sup> However, proponents of the new missiles claim the technology could actually increase stability by providing the key to penetrating current anti-access, area denial strategies.<sup>8</sup> In February 2019, Hyten testified that hypersonic weapons could deliver “responsive, long-range, strike options against distant, defended, and/or time-critical threats when other forces are unavailable, denied access, or not preferred.”<sup>9</sup>

The review of relevant literature combined with publicly available documents and statements reveal several problems related to the U.S. pursuit of hypersonic weapons. First, new

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<sup>4</sup> Jeffery Smith, “Hypersonic Missiles Are Unstoppable. And They’re Starting a New Global Arms Race,” *The New York Times Magazine*, June 19, 2019, under “In recent decades,”

<https://www.nytimes.com/2019/06/19/magazine/hypersonic-missiles.html>. (Accessed February 7, 2020).

<sup>5</sup> Richard Speier, George Nacouzi, Carrie Lee, and Richard M. Moore, *Hypersonic Missile Nonproliferation: Hindering the Spread of a New Class of Weapons* (RAND Corporation, 2017), 7-18; Congressional Research Service, *Hypersonic Weapons: Background and Issues for Congress*, 1.

<sup>6</sup> Congressional Research Service, *Hypersonic Weapons: Background and Issues for Congress*, 2-3.

<sup>7</sup> Speier, Nacouzi, Lee, and Moore, 35-42.

<sup>8</sup> Congressional Research Service, *Hypersonic Weapons: Background and Issues for Congress*, 4.

<sup>9</sup> Testimony of John E. Hyten: *Hearing on United States Strategic Command*, 16.

technology is changing the character of war, but no one is thinking about how or what is changing or how to adapt to the changes – a serious intellectual gap. Second, the perception of U.S. strategic weakness appears to be driving the desire to do something quickly. Third, hypersonic weapons development appears to be a reaction to Russian and Chinese research and design, and who now have been elevated in the National Security Strategy, National Defense Strategy, and National Military Strategy to strategic competitors. Fourth, the argument for hypersonic weapons is now a magic bullet to defeat Russia and China by negating anti-access, area denial strategies. Finally, hypersonics has become a shorthand term within the defense community indicating general ignorance of both the technology and its operational-strategic ramifications.

Hypersonic weapons will forever alter the character of war and reshape the concept of strategic deterrence, reshape the operational level of war, and transform warfighting in general. Hypersonic weapons will present an apparent contradiction of the future battlespace, simultaneously contracting it to the point it no longer represents a useful concept in warfare, while also creating an immediate global battlespace. These weapons will be synchronized in time, space, and purpose to achieve near instantaneous and paralyzing destruction. The strength of the offensive versus defensive will shift; even well defended targets deep in enemy territory will be at risk, surface fleets will become less effective and more vulnerable, bases will no longer be secure, large conventional ground force units will have little utility, and tactical aviation may become obsolete. Timely, accurate intelligence for targeting will become the key enabler, while warhead and target ambiguity provide flexibility.

This new character of war could be thought of as *hyperwar*, and history is replete with examples of the tragedy suffered by nations when they fail to recognize how the advent of a new

technology drastically changes the character of war. To ensure its future survival, the United States must understand how the advent of hypersonic weapons will alter warfare into hyperwar.

This research study explores the major operational effects resulting from the advent of hypersonic weapons, as well as some implications for America's strategic situation. The current development of hypersonic weapons, including the different types, as well as the on-going hypersonic arms race is discussed. An analysis of U.S. strategy regarding the military application of hypersonic weapons follows. Leveraging relevant military theory, history, innovation, and strategy, this study will show that U.S. leadership has a limited understanding of how the nature of hypersonic weapons will revolutionize the character of war. The author defines this altered character of war as *hyperwar* and will illustrate several key aspects of this concept. Finally, an assessment based on the theory of hyperwar will be provided to aid key leadership in transformative strategic thinking and inform subsequent hypersonic warfare research.

## Chapter 2: Revolution, Not Evolution

It is unfortunate that the discussion with HGVs [Hypersonic Glide Vehicles] is so frequently misunderstood as just a substitute for nuclear ICBMs.<sup>1</sup>

Dr. Thomas Karako

Hypersonic speed alone is not particularly useful on the modern battlefield; it is the combination of hypersonic speed, global range, maneuverability at lower altitude, and precision strike that provide a unique military capability never before available. While, this combination of characteristics makes these new missiles hard to defend against, they are also extremely challenging to develop.<sup>2</sup>

Hypersonic flight is not a new concept. Missile flight regimes are generally categorized as subsonic, or less than Mach 1; supersonic, between Mach 1 and Mach 5; and hypersonic, greater than Mach 5. The Mach number, named after Austrian physicist and philosopher Ernst Mach, was first proposed by aeronautical engineer Jakob Ackeret in 1929, and provides a useful concept to describe the true airspeed of high-altitude aerospace vehicles. The Mach number is a dimensionless quantity that represents the ratio of the velocity of local airflow compared to the local speed of sound. A Mach number of 1 represents a local airflow equal to the speed of sound, whereas Mach 5 represents a local airflow 5 times the speed of sound. For comparative purposes, missiles exceeding Mach 5 would be traveling faster than 3,300 knots (3,800 miles per hour, 6,100 kilometers per hour, or 1,700 meters per second).

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<sup>1</sup> Thomas Karako, interview by Rebecca Heinrichs, *China's Hypersonic Missile Advances and U.S. Defense Responses*, Hudson Institute Video, Mar 11, 2019, <https://www.hudson.org/events/1662-china-s-hypersonic-missile-advances-and-u-s-defense-responses32019>, (accessed February 7, 2020).

<sup>2</sup> Congressional Research Service, *Hypersonic Weapons: Background and Issues for Congress*, by Helley M. Saylor, July 11, 2019 (Washington, DC: Government Printing Office, 2019), 2-3.

The United States started to explore the hypersonic flight envelope during the space race in the 1950s as a critical enabling technology for space flight launch and recovery. The National Aeronautics and Space Administration (NASA) conducted the first successful manned hypersonic flight in 1959 using the X-15 rocket-propelled test vehicle and set the unofficial world record eight years later with the same vehicle, which achieved a speed of Mach 6.7 at an altitude around 250,000 feet.<sup>3</sup> Over the past 60 years, many other man-made vehicles have achieved hypersonic speeds including space flight re-entry capsules, ballistic missile re-entry vehicles, and the NASA Space Shuttle.

### Not the Only Long-Range Missile

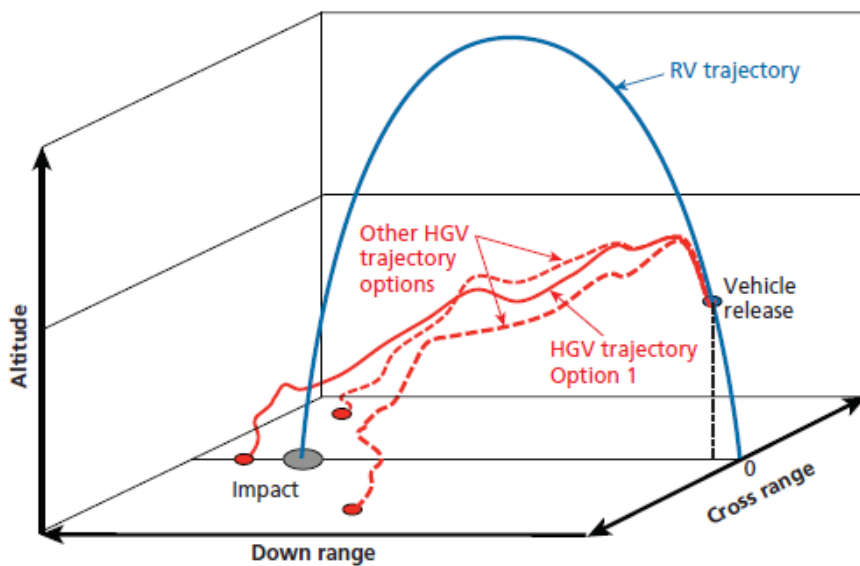
Hypersonic weapons provide an ability to create effects at extremely long ranges due to the speed of the weapon and flight profile. At speeds above Mach 5, a hypersonic glide vehicle is able to travel a great distance before gravity pulls it back to earth. For comparison, an average bullet travels around Mach 2 at sea level and can travel several miles without any aerodynamic lifting force before being pulled back to Earth. Shaping the glide vehicle in a way that creates aerodynamic lift helps counter the force of gravity and increases the glide distance. For example, an unpowered fighter aircraft, such as the F-16, will travel an average of 1 nautical mile for every one thousand feet of altitude when flying at a speed around 0.5 Mach. By combining hypervelocity speed with a lifting body and a starting altitude between 130,000 and 328,000 feet, a Hypersonic Glide Vehicle (HGV) can achieve ranges greater than 1,200 miles without leaving Earth's atmosphere.

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<sup>3</sup> Richard Speier, George Nacouzi, Carrie Lee, and Richard M. Moore, *Hypersonic Missile Nonproliferation: Hindering the Spread of a New Class of Weapons* (RAND Corporation, 2017), 50.

Ballistic missiles also have the ability to achieve ranges greater than 1,200 miles; however, since ballistic objects move only under the force of gravity with no lift, the flightpath of a ballistic missile resembles an unpowered projectile over the majority of the flight. Therefore, ballistic missiles must fly a high arc into space before returning back to Earth to travel a long distance. As shown in Figure 1.1, the difference in flight profile between a ballistic missile and a hypersonic missile is significant. The high-altitude flight profile of ballistic missiles causes them to rapidly fly above the long-range radar horizon early in the boost phase, which allows early detection and tracking by a small number of strategically placed ground-based radars.

**Figure 1.1**  
**Trajectory of Hypersonic Glide Vehicle and Ballistic Missile Re-entry Vehicle (RV)<sup>4</sup>**



However, the lower altitude, non-ballistic flight profile of HGVs makes long-range detection by ground-based radars nearly impossible, as radar signals are simply blocked by the curvature of the earth until the HGV is closer to the radar. The main disadvantage of an HGV is the increased thermal and pressure load on the air vehicle due to multiple minutes of hypersonic flight within

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<sup>4</sup> Ibid., 4.

the atmosphere, compared to less than one minute for a ballistic missile, which makes the technology significantly more difficult to develop than traditional ballistic missiles.<sup>5</sup>

### Maneuverability

Detection and target prediction are further complicated by a hypersonic missile's ability to maneuver throughout flight. Maneuverable Re-entry Vehicles (MaRVs) developed for use on ballistic missiles, are only able to make small maneuvers during the last 20 percent of the flight. HGVs are able to conduct aggressive maneuvers during approximately 80 percent of the flight. The only predictable portion of a hypersonic missile would be during the initial launch phase. Once in cruise, the missile would be able to maneuver throughout the remainder of the flight. This enhanced maneuvering capability provides HGVs with several advantages over traditional ballistic missiles, including the ability to avoid overflight of sensitive areas, increased survivability against air defenses, larger in-flight retargeting footprint to threaten large areas or massed forces, and a tailorable terminal approach angle for increased weapon system effectiveness.<sup>6</sup>

### Precision Hypersonic Strike

Given the high maneuverability of hypersonic missiles in the terminal phase of flight, these weapons are expected to perform similar to currently fielded precision munitions. Hypersonic missiles could be armed with either conventional or nuclear warheads, although given the high degree of accuracy that can be achieved, these missiles would not necessarily

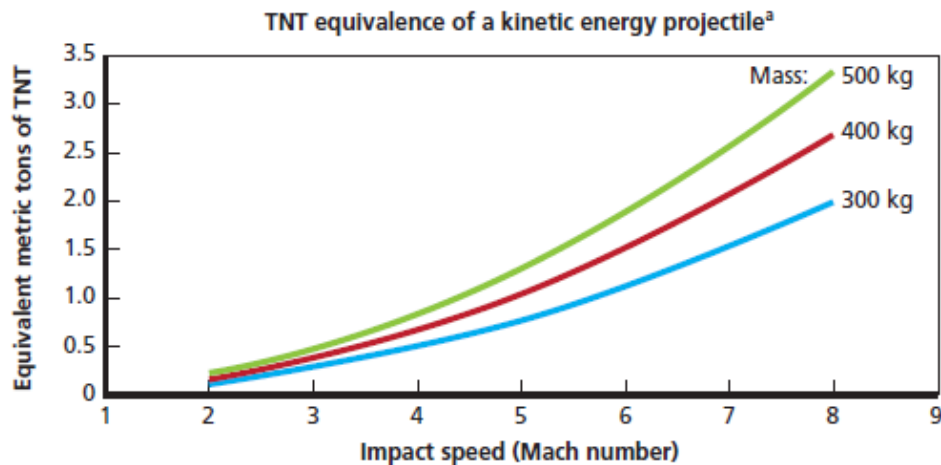
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<sup>5</sup> Ibid., 101.

<sup>6</sup> National Research Council, *U.S. Conventional Prompt Global Strike: Issues for 2008 and Beyond* (Washington, DC: The National Academies Press, 2008), 115.

require an explosive warhead to destroy most soft targets.<sup>7</sup> As shown in Figure 1.2, kinetic energy is primarily a function of speed, thus an air vehicle traveling at hypersonic speeds would produce an impact force greater than 500 kilograms of TNT. As the Mach number increases, the force of the impact also increases exponentially.

**Figure 1.2**  
**Destructive Power vs Impact Speed<sup>8</sup>**



<sup>a</sup> Assumes energy directed and focused along projectile direction and frontal area.

Among other advantages, the precision strike capability enables the non-nuclear destruction of deeply buried strategic targets.<sup>9</sup> Neither ballistic missiles, nor cruise missiles can destroy deeply buried targets. Ballistic missiles lack the accuracy and cruise missiles are too slow to generate sufficient kinetic energy required to penetrate deeply enough to destroy the target.

## Hypersonic Weapons Development

<sup>7</sup> National Research Council, *U.S. Conventional Prompt Global Strike*, 127-129.

<sup>8</sup> Speier, Nacouzi, Lee, and Moore, 13.

<sup>9</sup> James Acton, *Silver Bullet? Asking the Right Questions About Conventional Prompt Global Strike* (Washington D.C.: Carnegie Endowment for International Peace, 2013), 84-85.

Today, two weapon types are in development in China, Russia, and the United States, while other countries including Australia, India, France, Germany, and Japan are pursuing hypersonic weapon enabling technologies.<sup>10</sup> Hypersonic Glide Vehicles (HGVs) are initially boosted, usually by a ballistic missile rocket motor, to an altitude between 40 and 100 kilometers, then released to glide unpowered across the upper atmosphere at speeds up to Mach 20, while maneuvering to the target.<sup>11</sup> Hypersonic Cruise Missiles (HCMs) are typically smaller and shorter range than HGVs and are designed to be launched from aircraft, ships, or ground vehicles. HCMs are powered throughout flight using either a rocket, or an air-breathing engine, or a combination of the two, and fly at a lower altitude of 10 to 40 kilometers and speeds between Mach 5 and 15.<sup>12</sup>

## **China**

China's significant investment in hypersonic technology is likely in response to U.S. power projection in the Indo-Pacific region and its expanding ballistic missile defense system. Robert Haddick suggests that China has demonstrated a desire to achieve its national security goals through a patient, long-term strategy that uses small incremental changes to the security environment while implementing an advanced missile threat to prevent future roll back.<sup>13</sup> Haddick claims that since China's realization of America's conventional military capability during Operation DESERT STORM in 1991 and American power projection during the Taiwan Strait crisis between 1995 and 1996, led China to increase defense spending, reallocate defense resources from the land force to military modernization, and prioritize high-technology research

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<sup>10</sup> Speier, Nacouzi, Lee, and Moore, 2.

<sup>11</sup> Ibid., 8.

<sup>12</sup> Ibid., 12.

<sup>13</sup> Robert Haddick, *Fire on the Water: China, America, and the Future of the Pacific* (Annapolis, MD: Naval Institute Press, 2014), 77.

and expansion of the military industrial base.<sup>14</sup> Roger Zakheim, echoing Haddick, claims that China's industrial base is ahead of the U.S. in developing a hypersonic weapons capability.<sup>15</sup>

China's ability to field long-range anti-ship cruise missiles, anti-ship ballistic missiles, stealth aircraft prototypes, and space capabilities faster than predicted has surprised many in the U.S. intelligence community.<sup>16</sup> While China's near-term defense strategy appears focused on regional hegemony, many defense programs still in development foreshadow out of region ambitions in the mid- and long-term. Chinese hypersonic weapons under development include the DF-41 ICBM-boosted HGV with an unlimited range, the MDF-17 MRBM-boosted HGV with a range of 1,500 miles, the DF-ZF HGV with a range of 1,200 miles, and the nuclear-capable Starry Sky-2 "Waverider" HGV.<sup>17</sup>

## **Russia**

Russia is aggressively pursuing hypersonic weapons to preserve a viable nuclear second-strike capability in response to expanding U.S. missile defense systems.<sup>18</sup> Christopher Ford, Assistant Secretary of State for International Security and Nonproliferation, recently stated in testimony before the U.S. Senate Foreign Relations Committee that "Russia is presently developing an extraordinary new bestiary of nuclear delivery systems for which there are no U.S. counterparts ... includ[ing] not merely the new *Sarmat* [ICBM], but also hypersonic delivery vehicles, a nuclear-powered underwater drone, and the madly reckless "flying Chernobyl" of the *Burevestnik* nuclear-powered cruise missile."<sup>19</sup> Russia recently reported the operational fielding

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<sup>14</sup> Ibid., 82.

<sup>15</sup> Roger Zakheim, interview by Rebecca Heinrichs, *China's Hypersonic Missile Advances and U.S. Defense Responses*, Hudson Institute Video, Mar 11, 2019, <https://www.hudson.org/events/1662-china-s-hypersonic-missile-advances-and-u-s-defense-responses32019>, (accessed February 7, 2020).

<sup>16</sup> Haddick, 82-83.

<sup>17</sup> Congressional Research Service, *Hypersonic Weapons: Background and Issues for Congress*, 13.

<sup>18</sup> Ibid., 9-10.

<sup>19</sup> Testimony by Honorable Christopher A. Ford, Foreign Relations Committee, *Countering Russian Intimidation and Aggression and Building a Better Security Environment*, 116<sup>th</sup> Cong., 1<sup>st</sup> sess., December 3, 2019, 2.

of the Kh-47M2 *Kinzhal*, a Mach 10, air-launched hypersonic missile with a 1,200-mile range, and is actively developing two additional hypersonic weapons: a Mach 20, ICBM-boosted *Avangard* HGV with an unlimited range, and a Mach 8, ship-launched *Tsirkon* HCM with a 600-mile range.<sup>20</sup>

## **United States**

While the United States has been investing in hypersonic weapons since 2001, and is developing several hypersonic weapon concepts, it has little to show for its efforts in regards to operational weapons systems. In June 2018, the U.S. Navy was named the lead service to develop a common HGV to be used by each service specific program. The Navy Intermediate Range Conventional Prompt Strike Weapon would combine the common HGV with a SLBM-booster, while the Army's Long Range Hypersonic Weapon would mate the common HGV with a two-stage ground-launched booster.<sup>21</sup> Similarly, the U.S. Air Force's Hypersonic Conventional Strike Weapon would pair the common HGV with an air-launched, rocket-booster employed from a B-52. The Air Force is also developing the AGM-183A Air-launched Rapid Response Weapon that will use a unique HGV capable of Mach 20 flight.<sup>22</sup> Additionally, the Defense Advanced Research Program Agency (DARPA) is pursuing several other hypersonic weapon capabilities in partnership with the military, however these programs are not expected to be operational for some time.<sup>23</sup>

DoD has delayed a decision on whether to procure hypersonic weapons until the technology matures, more information is available regarding potential mission sets for hypersonic weapons, a cost assessment of alternatives can be conducted, and enabling

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<sup>20</sup> Congressional Research Service, *Hypersonic Weapons: Background and Issues for Congress*, 12.

<sup>21</sup> *Ibid.*, 5-6.

<sup>22</sup> *Ibid.*, 6.

<sup>23</sup> *Ibid.*, 5-8.

technologies can be evaluated.<sup>24</sup> The lack of well-defined mission requirements have made it difficult for Congress to balance funding levels, but it is clear the United States is prioritizing offensive strike capability over defensive systems.<sup>25</sup>

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<sup>24</sup> Ibid., 15.

<sup>25</sup> Ibid.

## Chapter 3:

### Where do hypersonic weapons fit into U.S. military strategy?

The military tend to have an ambivalent attitude to technological advance. They will embrace readily those incremental developments that allow them to perform their traditional roles even better, but view with suspicion anything new that appears to require radical departures from established methods or, worse still, suggests the progressive obsolescence of their own brand of warfare.<sup>1</sup>

Lawrence Freedman  
*The Evolution of Nuclear Strategy*

Freedman made this observation during the advent of nuclear weapons and ballistic missiles, and it seems to ring true today in regards to America's development of hypersonic weapons. Freedman explains how the military as a whole often struggles to understand the full potential of revolutionary technologies especially when it has the potential to threaten the established American concepts of warfighting. The U.S. Navy's response to China's growing land-based missile and aircraft capability that can hold surface targets at risk out to two thousand kilometers, serves as a recent example. A RAND study concluded the Navy should move away from "striking power centered on the aircraft carrier, protected by expensive multi-mission destroyers, and proposed a design characterized by many small combatants, more submarines, unmanned aircraft and ships, and decoys and deception measures, all tied by robust communication links."<sup>2</sup> Other strategic military experts went further and recommended the U.S. Navy move away from carrier-based strike aircraft, towards long-range land-based strike aircraft currently under development for the Air Force.<sup>3</sup> However, neither of these radical departures from the Navy's established methods are being pursued by its leadership.

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<sup>1</sup> Lawrence Freedman, *The Evolution of Nuclear Strategy*, 2<sup>nd</sup> ed. (New York: St. Martin's Press, 1989), 24.

<sup>2</sup> Robert Haddick, *Fire on the Water: China, America, and the Future of the Pacific* (Annapolis, MD: Naval Institute Press, 2014), 199-200.

<sup>3</sup> *Ibid.*, 193.

The U.S. was the world leader in hypersonic technology during the Cold War because it was an enabler for the national space program, as well as the nuclear ballistic missile program. At the time, none of the military services were interested in spending significant portions of their budget on ICBMs, which they viewed as a potential replacement for long-range bombers, ballistic missile submarines, and long-range artillery forces. This reluctance to back away from traditional weapons systems resulted in a fairly slow and haphazard development process. The U.S. hypersonic weapons development appears to be suffering a similar fate under the Conventional Prompt Global Strike (CPGS) program umbrella, which all U.S. hypersonic programs are currently funded.

#### Evolution of Conventional Prompt Global Strike

After the fall of the Soviet Union in 1991, there was no shortage of conflict around the globe, but America struggled with the use of force to solve its problems. International trends during this period included global economic integration, the erosion of modern state structures, the rise of non-state actors, ethnic and religious conflict, and humanitarian crises. Not having high confidence on what actors would pose threats to vital U.S. interests or those of its allies, the President George W. Bush administration determined a capabilities-based approach to defense was required to broaden the U.S. strategic perspective.<sup>4</sup>

Instead of focusing on a specific nation or threat, which had previously been the Soviet Union, the new defense strategy intended to identify military capabilities that could “deter and defeat adversaries who will rely on surprise, deception, and asymmetric warfare to achieve their objectives.”<sup>5</sup> The new “capabilities-based force” would allow the United States to exploit

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<sup>4</sup> U.S. Department of Defense, *Quadrennial Defense Review Report* (Washington D.C., 2001), 13-14.

<sup>5</sup> Ibid.

opportunities to overcome anti-access and area denial threats using certain emerging capabilities, including “advanced remote sensing, long-range precision strike, transformed maneuver and expeditionary forces and systems.”<sup>6</sup> The DoD even envisioned some of these emerging capabilities replacing portions of the nuclear triad with conventional weapons as seen in the 2001 Nuclear Posture Review that identified a “new triad” with the first leg composed of “offensive strike systems (both nuclear and non-nuclear).”<sup>7</sup> CPGS was one of the defense programs that tried to leverage these emerging capabilities.

DoD formally initiated the CPGS program in May of 2003 with the general requirement to develop a high-precision, conventional weapon capable of striking a target anywhere on the globe in under an hour from the launch decision.<sup>8</sup> The 2006 Quadrennial Defense Review reported that the DoD intended to “convert a small number of Trident [SLBMs] for use in conventional prompt global strike” as something of an all-purpose solution to U.S. national security, intended to “shape the choices of countries at strategic crossroads, strengthen deterrence, and hedge against future strategic uncertainty.”<sup>9</sup> A 1995 RAND study and 2004 Defense Science Board study both advocated converting retired nuclear ballistic missiles to conventional global strike systems as a relatively cheap option to deploy a capability quickly leveraging existing technology to save development time, cost, and risk.<sup>10</sup> Although Congress ultimately elected to not fund the Conventional Trident Modification program it did support the

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<sup>6</sup> Ibid.

<sup>7</sup> U.S. Department of Defense, *Nuclear Posture Review* [Excerpts] (Washington D.C., 2001), <http://web.stanford.edu/class/polisci211z/2.6/NPR2001leaked.pdf> (Accessed February 7, 2020).

<sup>8</sup> James Acton, *Silver Bullet? Asking the Right Questions About Conventional Prompt Global Strike* (Washington D.C.: Carnegie Endowment for International Peace, 2013), 4.

<sup>9</sup> U.S. Department of Defense, *Quadrennial Defense Review Report* (Washington D.C., 2006), 6.

<sup>10</sup> Acton, *Silver Bullet*, 11.

Pentagon's CPGS concept.<sup>11</sup> Subsequent military efforts have since shifted towards the development of new non-ballistic missile systems.

The Trump administration breathed new life into the program and mandated the CPGS weapons system reach early operational capability no later than the end of fiscal year 2022.<sup>12</sup> Subsequently, the role of hypersonic weapons in the national defense strategy appears to have outgrown the original CPGS requirements. While the early intent of the CPGS program appeared to be centered on a potential counterterrorism role, today's advocates have expanded the use to include more state-centric threats, such as countering an adversary's nuclear forces, anti-satellite weapons, and anti-access, area denial capabilities.<sup>13</sup>

### Return to Great Power Competition

The reason for the current administration to deploy hypersonic weapons is found in the 2018 National Defense Strategy which proclaims that the United States is “emerging from a period of strategic atrophy, aware that our competitive military advantage has been eroding,” and the Department of Defense should now be primarily concerned with “inter-state strategic competition, not terrorism.”<sup>14</sup> The strategy further states that “long-term strategic competitions with China and Russia are the principle priorities for the [Defense] Department, and require both increased and sustained investment.”<sup>15</sup> This is a clear shift in America's defense priorities, and represents the first time since the Cold War that a U.S. defense strategy specifically again names Russia and China as emerging threats. The strategy articulates that “the security environment is

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<sup>11</sup> Ibid., 1-2.

<sup>12</sup> *National Defense Authorization Act for Fiscal Year 2018*, Public Law 115-91, 115<sup>th</sup> Cong., 1<sup>st</sup> sess. (December 12, 2017), 1791.

<sup>13</sup> Acton, *Silver Bullet*, 9.

<sup>14</sup> U.S. Department of Defense, *Summary of the 2018 National Defense Strategy of the United States*, (Washington DC: Government Printing Office, 2018), 1.

<sup>15</sup> Ibid., 4.

also affected by *rapid technological advancements and the changing character of war*,” but fails to provide any additional details.<sup>16</sup>

A review of publicly available U.S. strategic documents does not provide a clear understanding of how the U.S. plans to integrate hypersonic weapons into its overall defense strategy. There are many references to leveraging hypersonic weapons technology, but the documents fail to provide any substantial supporting concepts. James Acton has observed that “the U.S. has not had a proper discussion of the benefits and risks of this technology.” Acton himself sees no indication of strategic thinking. “By far the most common argument you hear in favor of development of hypersonic technology, particularly in Congress,” he noted, is “Russia is doing it, China is doing it, therefore we must do it.”<sup>17</sup>

### **Anti-Access, Area Denial**

Proponents of the new hypersonic missiles claim the technology is the key to penetrating current anti-access, area denial (A2/AD) strategies.<sup>18</sup> Anti-access, area denial consists of the combination of actions, activities, or capabilities, designed to prevent opposing forces from entering an operational area or limit the opposing force’s freedom of action within an operational area.<sup>19</sup> Anti-access, area denial capabilities are becoming a significant part of Chinese and Russian strategic-operational thinking and consist of a wide variety of surface-to-air, ballistic, and cruise missiles, fighter aircraft, naval surface ships, and submarines. In February 2019, General John E. Hyten, commander of United States Strategic Command, testified that

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<sup>16</sup> Ibid., 3.

<sup>17</sup> Jeff Smith, Dean Wilkening, Amy Wolfe, interview by James Acton, *Hypersonic Missile: Assessing the Benefits and Risks*, Carnegie Endowment Video, July 9, 2019, <https://carnegieendowment.org/2019/07/09/hypersonic-missiles-assessing-benefits-and-risks-event-7151> (Accessed February 7, 2020).

<sup>18</sup> Congressional Research Service, *Hypersonic Weapons: Background and Issues for Congress*, by Helley M. Saylor, July 11, 2019 (Washington, DC: Government Printing Office, 2019), 4.

<sup>19</sup> U.S. Department of Defense, *DoD Dictionary of Military Terms* (Washington D.C.: Government Printing Office, 2019), 19.

hypersonic weapons could deliver “responsive, long-range, strike options against distant, defended, and/or time-critical threats when other forces are unavailable, denied access, or not preferred.”<sup>20</sup>

Other defense experts seem more concerned with how the United States would deter an adversary that possesses hypersonic weapons. Michael Griffin, the Under Secretary of Defense for Research and Engineering, stated during congressional testimony in 2018 that he was most concerned about the growing disadvantage in hypersonic weapons technology between the United States and Russia and China.<sup>21</sup> Griffin testified that the United States lacked corresponding hypersonic weapons systems compared to Russia and China, as well as active defenses against those systems.<sup>22</sup> He stated, “It is among my very highest priorities to erase that disadvantage, creating our own [U.S.] systems to hold them at risk and to provide defense.”<sup>23</sup> Building on Griffin’s concern, Roger Zakheim, a member of the Commission on the National Defense Strategy of the United States, stated “Adversaries that possess hypersonic missiles are at the heart of the A2/AD challenge.”<sup>24</sup> He noted that “these advanced weapons pose the greatest risk to U.S. freedom of maneuver in the Pacific Theater, and undermine U.S. ability to uphold treaty obligations and commitments with allies and partners.”<sup>25</sup>

### **Misuse of the term “hypersonics”**

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<sup>20</sup> Committee on Armed Services, *Statement of John E. Hyten, Commander United States Strategic Command*, 116<sup>th</sup> Cong., 1<sup>st</sup> sess., February 26, 2019, 16.

<sup>21</sup> Christian Davenport, “Why the Pentagon fears the U.S. is losing the hypersonic arms race with Russia and China,” *Washington Post*, June 8, 2018, <https://www.washingtonpost.com/business/economy/why-the-pentagon-fears-the-us-is-losing-the-hypersonic-arms-race-with-russia-and-china/2018/06/08> (Accessed November 15, 2019).

<sup>22</sup> *Ibid.*

<sup>23</sup> *Ibid.*

<sup>24</sup> Roger Zakheim, interview by Rebecca Heinrichs, *China’s Hypersonic Missile Advances and U.S. Defense Responses*, Hudson Institute Video, Mar 11, 2019, <https://www.hudson.org/events/1662-china-s-hypersonic-missile-advances-and-u-s-defense-responses32019>, (accessed February 7, 2020).

<sup>25</sup> *Ibid.*

Part of the confusion surrounding where hypersonic weapons fit in U.S. strategy may stem from the widespread and incorrect use of the term hypersonics, when those who use the term are actually referring to hypersonic glide vehicles or hypersonic cruise missiles.<sup>26</sup> The National Defense Strategy lists “hypersonics” as one of the eight key technologies in the security environment that the U.S. needs to ensure it will be able to fight and win the wars of the future.<sup>27</sup> Griffin also referred to hypersonic weapons in a similar fashion. “I’m sorry for everybody out there who champions some other high priority, some technical thing,” he said in a recent interview, “it’s not that I disagree with those, but there has to be a first, and hypersonics is [*sic*] my first.”<sup>28</sup>

Dr. Thomas Karako, a senior fellow with the International Security Program and director of the Missile Defense Project at the Center for Strategic and International Studies, recently pointed out the use of the term hypersonics as a noun is both imprecise and misleading.<sup>29</sup> It is imprecise because it refers only to a speed, when in actuality, hypersonic weapons consist of a variety of different flight vehicles or missiles with different atmospheric flight profiles and weapon characteristics. It is also misleading because the benefits and challenges with hypersonic weapons are about more than just the speed.

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<sup>26</sup> U.S. Department of Defense, *Summary of the 2018 National Defense Strategy*, 3.

<sup>27</sup> *Ibid.*

<sup>28</sup> Jeffery Smith, “Hypersonic Missiles Are Unstoppable. And They’re Starting a New Global Arms Race,” *The New York Times Magazine*, June 19, 2019, under “In recent decades,” <https://www.nytimes.com/2019/06/19/magazine/hypersonic-missiles.html>. (Accessed February 7, 2020).

<sup>29</sup> Thomas Karako, interview by Rebecca Heinrichs, *China’s Hypersonic Missile Advances and U.S. Defense Responses*, Hudson Institute Video, Mar 11, 2019, <https://www.hudson.org/events/1662-china-s-hypersonic-missile-advances-and-u-s-defense-responses32019>, (accessed February 7, 2020).

## Chapter 4:

### Hypersonic Weapons and the New Reality: Hyperwar

The American way in defense preparation as well as war has emphasized the technical and logistical rather than the politically well-informed and operationally agile.<sup>1</sup>

Colin Gray  
*Strategy in the Nuclear Age*

The trend in modern wars has been an increase in the tempo of warfare and use of increased weapon standoff. Radical advances in sensor, computing, robotic, and material technologies are creating a condition where the speed of tactical action outpaces human limits. As a result, some nations have pursued man-machine augmentation to provide an advantage. High-fidelity, persistent, space-based sensors, combined with rapid intelligence collection aided by machine learning, and automated mission planning using artificial intelligence have already begun to shorten decision and targeting cycles, and created a growing desire for the synchronization and integration of effects across all domains. The nascent ability to deliver near instantaneous effects in the information and electromagnetic spectrum domain already exists, and with the advent of hypersonic weapons, military forces will have a similar ability in the air, sea, and land domains. This confluence of technology, speed, and precision will lead to hyperwar.

Hyperwar can be characterized by diminished strategic deterrence, a broadening of the operational level of war in complexity and scope, and a shift in favor of the offense. At the strategic level, states will be constantly challenged with the threat of surprise attack, compressed decision-making timelines, and increased risk of miscalculation. At the operational level, the

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<sup>1</sup> Colin Gray, "Strategy in the Nuclear Age: The U.S., 1945-1991," in *The Making of Strategy: Rulers, States, and War*, edited by Williamson Murray, McGregor Knox, and Alvin Bernstein (Cambridge: Cambridge University Press, 1994), 593.

demand to integrate and synchronize operations across all domains, including the air, land, maritime, space, and cyberspace domains will entail exponential complexity. Warfare in general will become faster than unaided human perception is able to process, and with limited means to defend as well as limited time to react, the offense will dominate the battlespace.

### Strategic Deterrence

With the proliferation of hypersonic weapons, no states will be secure from surprise attack. The hypersonic speed combined with the ability to fly below or avoid long-range radar coverage will elude early warning systems. “Hypersonic weapons of the type we are talking about here present both tactical warning and attack assessment challenges,” stated Dr. Austin Long, nuclear policy advisor serving in the Joint Chiefs of Staff J5, Strategic Deterrence and Nuclear Policy Division, “it is that combination of characteristics that makes hypersonic weapons so challenging for integrated threat warning and attack assessment.”<sup>2</sup>

Moreover, it will be nearly impossible to verify whether a nuclear or conventional attack is underway. The United States currently relies on two independent sources to verify a nuclear attack. Space-based overhead persistent infrared sensors are used to detect the initial boost phase of a ballistic missile launch, while an independent ground-based radar system has a correlated track to verify the launch and calculate the missile trajectory. The use of dual phenomenology, Long stated:

is really important to prevent false positives of attack, there are sometimes systems errors, but to have both infrared and radar systems detect the same anomaly is extremely unlikely. There are potentially ways to deal with this, both from a threat warning and attack assessment problem but they are quite challenging. If you want to do dual phenomenology, and you want to use radar,

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<sup>2</sup> Austin Long, interview by Rebeccah Heinrichs, *China’s Hypersonic Missile Advances and U.S. Defense Responses*, Hudson Institute Video, Mar 11, 2019, <https://www.hudson.org/events/1662-china-s-hypersonic-missile-advances-and-u-s-defense-responses32019> (Accessed February 7, 2020).

you will need a whole lot more radars, you will have to proliferate radars or start relying on radars that are less reliable like over-the-horizon radars.<sup>3</sup>

In hyperwar, the lack of reliable early warning creates crisis instability that invites nations to fall victim to a use-it-or-lose-it mentality, in which the ambiguity of potential targets could lead to miscalculation and unintended escalation. The “reciprocal fear of surprise attack” may present itself during periods of heightened tension between two adversaries armed with hypersonic weapons when a reasonable chance for war exists for other reasons, and both sides possess the capability to launch a first strike and one opponent possesses a sizeable first strike capability.<sup>4</sup> ICBMs protected by concrete shelters become more vulnerable as the precision of an opponent’s re-entry vehicles improves.<sup>5</sup> Precision strike capability will likely increasingly overcome passive and active defense measures over the next 10-20 years.<sup>6</sup> This forecast assumes the technology trend of the current era that favors offensive missiles.

The use of passive defenses will be critical to protect military capabilities in hyperwar, although static forms of defense will become less effective. Slow moving surface fleets, forward air bases, and non-maneuverable aircraft will become extremely vulnerable to hypersonic missile attack. Land forces will need to use mobile, dispersed operations to enhance survivability. A recent RAND study concluded that “eventually, breakthroughs in sensor technology may make any platform, anywhere, observable and vulnerable.”<sup>7</sup>

Nuclear forces, once believed to be survivable against all but a direct nuclear strike, could be held at risk by the enormous kinetic energy and precision strike capability of a small number

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<sup>3</sup> Ibid, interview.

<sup>4</sup> Lawrence Freedman and Jeffrey Michaels, *The Evolution of Nuclear Strategy*, 4<sup>th</sup> ed. (London: Palgrave Macmillan), 203-204.

<sup>5</sup> Freedman and Michaels, 201.

<sup>6</sup> Robert Haddick, *Fire on the Water: China, America, and the Future of the Pacific* (Annapolis, MD: Naval Institute Press, 2014), 112.

<sup>7</sup> Ibid., 200.

of conventional hypersonic weapons. To a certain extent, hypersonic weapons neutralize nuclear weapons without the extreme damage of a nuclear strike. They are cheaper, require less maintenance, and can achieve nuclear-like effects without the after effects of a nuclear strike.

Active defenses would prove to be technically challenging and expensive to develop. Defending a large area against hypersonic weapons is beyond the technological capabilities currently available. While not impossible, creating wide area anti-hypersonic defenses will require, at a minimum, the development of a new sensor layer, a new interceptor, and a totally different command and control system. While the U.S. has heavily invested in counter ballistic missile technology over the past 30 years, and recently developed the Ballistic Missile Defense System (BMDS), it will not effectively defend against HGVs due to the significantly different flight profile and mid-course maneuver capability.<sup>8</sup>

In hyperwar, the ability to detect, identify, track, and predict the trajectory of an incoming hypersonic weapon with enough time to interdict the flight with an interceptor represents the most significant challenge to using active defense measures. The opportunities for deception are great, while the tolerance for failure is small, and active defense measures can always be overwhelmed with large numbers of weapons.<sup>9</sup> “You are going to need an entirely new sensor layer,” stated Dr. Thomas Karako, “the peppering of the entire Pacific with radars is not going to happen, there are not enough islands.”<sup>10</sup> Additionally, even with elevated sensors to enable longer-range detection and tracking of hypersonic weapons, current air frames and interceptors will need to be adapted to handle the speed and flight profile requirements of hypersonic weapon

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<sup>8</sup> Thomas Karako, interview by Rebecca Heinrichs, *China's Hypersonic Missile Advances and U.S. Defense Responses*, Hudson Institute Video, Mar 11, 2019, <https://www.hudson.org/events/1662-china-s-hypersonic-missile-advances-and-u-s-defense-responses32019>, (accessed February 7, 2020).

<sup>9</sup> Freedman and Michaels, 195.

<sup>10</sup> Karako, interview.

defense.<sup>11</sup> Lastly, the command and control requirements of a hypersonic weapon defense system will be more complex than the current Command and Control, Battle Management, and Communications (C2BMC) system in use by the United States for the BMDS.<sup>12</sup>

### **Decreased reaction time**

In hyperwar, strategic decision-making timelines will be compressed. The current timeline for an offensive nuclear ICBM attack from Russia to the United States assumes each nation would have approximately 25 minutes of decision space before the majority of nuclear warheads would detonate. A 2017 RAND report illustrated the expected timeline to act based on a Nuclear Threat Initiative Organization analysis, as follows:

- 0 minutes – Russia launches missiles;
- 1 minute – U.S. satellite detects missiles;
- 2 minutes – U.S. radar detects missiles;
- 3 minutes – North American Aerospace Defense Command (NORAD) assesses information (2 minutes max);
- 4 minutes – NORAD alerts White House;
- 5 minutes – first detonations of submarine-launched ballistic missiles;
- 7 minutes – locate president and advisers, assemble them, brief them, get decision (8 min max);
- 13 minutes – decision;
- 15 minutes – transmit orders to start launch sequence;
- 20 minutes – launch officers receive, decode, and authenticate orders;
- 23 minutes – complete launch sequence (2 minutes max), and;
- 25 minutes – Russian ICBM detonation.<sup>13</sup>

The challenge of threat warning and attack assessment presented by hypersonic weapons will reduce the decision space for national leadership. The reduced decision timeline is primarily a factor of surprise and proximity, not speed. Because the flight profile of hypersonic weapons is

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<sup>11</sup> Ibid., interview.

<sup>12</sup> Ibid., interview.

<sup>13</sup> Richard Speier, George Nacouzi, Carrie Lee, and Richard M. Moore, *Hypersonic Missile Nonproliferation: Hindering the Spread of a New Class of Weapons* (RAND Corporation, 2017), 16.

slightly slower than ballistic missiles, they have a slightly longer flight time than a ballistic missile over the same distance. However, the ability for hypersonic weapons to deny threat warning and attack assessment during the early portion of the flight profile creates significant delays in the notification of attack to national level decision-makers. Even with enhanced sensors to provide earlier warning and assessment, hypersonic weapons launched from air, sea, and space platforms from a shorter range would reduce the flight time, and thus the decisionmaker's reaction time. For example, a hypersonic weapon launched from 1,000 kilometers would provide as little as 6 minutes of decision space.<sup>14</sup>

### **No assured deterrence**

The lack of assured deterrence due to warhead and target ambiguity also creates uncertainties that can lead to miscalculation. There will be no clear delineation between nuclear and conventional systems in hyperwar.<sup>15</sup> According to Zakheim, "There is a heavy emphasis on deterrence in the National Defense Strategy, and while top defense officials believe we can deter today, the proliferation of hypersonic weapons sparks questions on what deterrence looks like in the future."<sup>16</sup>

The literature has emphasized the importance of warhead ambiguity as a key security concern related to the fielding of hypersonic weapons. Warhead ambiguity describes the inability for an opponent to know with certainty that an incoming weapon is armed with a nuclear or conventional warhead. This uncertainty could then lead to miscalculation and escalation to a nuclear response. Similar to warhead ambiguity, target ambiguity will increase the flexibility and

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<sup>14</sup> Ibid., 17.

<sup>15</sup> National Research Council, *U.S. Conventional Prompt Global Strike: Issues for 2008 and Beyond* (Washington, DC: The National Academies Press, 2008), 72.

<sup>16</sup> Roger Zakheim, interview by Rebecca Heinrichs, *China's Hypersonic Missile Advances and U.S. Defense Responses*, Hudson Institute Video, Mar 11, 2019, <https://www.hudson.org/events/1662-china-s-hypersonic-missile-advances-and-u-s-defense-responses32019>, (accessed February 7, 2020).

uncertainty of an offensive attack. Target ambiguity is the inability for an opponent to determine with certainty the intended target of a hypersonic missile during flight. Unlike ballistic missiles that have a predictable flight path based on the initial launch trajectory, hypersonic missiles maintain moderate to high maneuverability after the short initial boost phase.

Acton emphasizes in chapter five of his analysis that the issue of warhead ambiguity only arises in situations where the opponent is capable of detecting the launch of a hypersonic weapon and initiating a nuclear retaliation before the effects of the attack can be assessed.<sup>17</sup> Currently, warhead ambiguity is only a concern for the United States and Russia because they are the only states that possess advanced early warning systems. However, in hyperwar the existence of hypersonic weapons makes a devastating first strike against a nuclear power very easy and limits the chance for a nuclear counterstrike. Nuclear armed powers may no longer, by default, be the strategic power brokers in the future. North Korea, via a relatively limited hypersonic missile strike, could be rendered defenseless as its nuclear forces are destroyed. The same could be said for Israel.

The future may belong to those states who have hypersonic weapons in such numbers as to threaten any country with the destruction of its conventional and nuclear forces within minutes. Hyperwar is about hair trigger threats, extreme ambiguity and uncertainty, and mutual vulnerability. Hyperwar, if it begins, will be concluded within 24-48 hours and decisive action occurs within the first 3-5 hours of initiation. Advanced early warning can bring some level of security and stability, but it will never be absolute, nor will it serve as a significant deterrent.

## Operational Level of War

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<sup>17</sup> James Acton, *Silver Bullet? Asking the Right Questions About Conventional Prompt Global Strike* (Washington D.C.: Carnegie Endowment for International Peace, 2013), 114.

In hyperwar, the operational level of warfare will become increasingly complex and less distinguishable from the strategic and tactical levels of warfare. The operational level of warfare is defined in U.S. military joint doctrine as “the level of warfare at which campaigns and major operations are planned, conducted, and sustained to achieve strategic objectives within theaters or other operational areas.”<sup>18</sup> This definition uses physical space as one of the delineations between the levels of war, and conveys the idea that major military operations are limited to a geographical region. However, recent information, cyber, and space operations have already displayed an ability to achieve near instantaneous effects around the globe. Now with the advent of conventional hypersonic weapons, the scope of military operations expands well beyond any defined geographic region. The concept of a *theater of operations* or a local *battlefield* becomes meaningless and potentially misleading to the military planner. The same can be said, but to a lesser degree, for other military terms such as the *theater of war*, *operational area*, and *joint operations area*.

The operational environment in hyperwar will expand to cover the entire globe. U.S. military joint doctrine defines the operational environment as “a composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander.”<sup>19</sup> Unlike the majority of recent combat operations that were isolated to a specific area or region, the addition of longer-range conventional hypersonic weapons will significantly expand the operational reach of conventional military forces to attack an adversary’s forces in depth. Military forces preparing for deployment, moving to the theater of operations, or reconstituting post redeployment will be vulnerable. Some experts contend this

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<sup>18</sup> U.S. Department of Defense, *DoD Dictionary of Military Terms* (Washington D.C.: Government Printing Office, 2019), 161.

<sup>19</sup> *Ibid.*, 160.

characteristic of hyperwar has already been realized to some extent. Lt Gen Eric Wesley, the Deputy Commanding General of the U.S. Army's Futures and Concepts Center, recently stated in an interview that he believes we already live in a world where "the operational environment is global."<sup>20</sup>

While physical space differences between the levels of war are directly referenced in the U.S. military joint definition, the relationship of time between the decision to act and the realization of the act is also implied. The act of planning, conducting, and sustaining campaigns and major operations is highly dependent on the speed of operations and ability of the commander to make timely operational decisions. The time between the execution decision and environmental effects tends to be short at the tactical level, moderate at the operational level, and longer at the strategic level. With the growth of near instantaneous electromagnetic spectrum effects such as electronic attack weapons, cyber weapons, directed energy weapons, and now the advent of long-range, hypersonic kinetic weapons, commanders can reduce the time between the employment decision and the resulting effects over vast distances on the full spectrum of an adversary's capabilities. The realization of immediate long-range effects, combined with an enabling global integrated real-time sensor network, will obscure the implied time differentiation between the levels of war.

Organizations at the operational level of war will be responsible for planning, conducting, and sustaining major operations that must account for global effects and a rapid decision cycle. In this extremely fast-paced environment, that has the ability to transition rapidly across multiple domains, operational level commanders will need to be extremely capable to anticipate

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<sup>20</sup> Lt Gen Eric Wesley, interviewed by Col (Ret) Daniel Roper, *Special Edition: Multi-Domain Operations-Joint and Allied Integration* (September 30, 2019), [https://www.podbean.com/media/share/pb-g2jms-c1201e?utm\\_campaign=au\\_share\\_ep&utm\\_medium=dlink&utm\\_source=au\\_share](https://www.podbean.com/media/share/pb-g2jms-c1201e?utm_campaign=au_share_ep&utm_medium=dlink&utm_source=au_share) (accessed February 7, 2020).

operational requirements. “The world gets smaller and smaller and smaller, and the operational environment gets increasingly hyperactive,” stated Wesley during a recent interview on Multi-Domain Operations, “we can no longer look at [the European and Indo-Pacific] theater, or any theater, as something that we prepare for after conflict starts.”<sup>21</sup>

Humans will become the limiting factor in the hyperwar decision-cycle. As the speed of conflict, range of operations, and level of action within warfighting domains continues to increase, the pace and complexity of warfare will challenge unaided human perception. Advanced computer technology, including artificial intelligence and machine learning, will need to augment operational decision-making processes and critical command and control functions to preserve decision space in hyperwar in terms of action, reaction, and counteraction.

Significant advantage will be gained by the command and control system that can integrate and synchronize command and control, intelligence, fires, movement and maneuver, protection, sustainment, and information functions across all domains more quickly than an opponent. The U.S. Army’s most recent operating concept, Multi-domain Operations, is based on the idea of creating overmatch by integrating all war fighting domains into one selective decisive space to create a synergistic effect.<sup>22</sup>

However, the integration and synchronization of forces in time, space, and purpose to achieve unified effects becomes exponentially more complex as each new domain represents an additional operational dimension. The operational artist in hyperwar will need to think and leverage resources across all domains. The hypersonic weapon will dominate the battlespace – how the operational artist thinks and acts in time and space at the appropriate speed of action, reaction, and counteraction is the nature of hyperwar.

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<sup>21</sup> Ibid., interview.

<sup>22</sup> Ibid., interview.

## Warfighting in General

The strength of the offense in hyperwar will increase substantially once the capabilities exist with hypersonic weapons to attack an adversary's anti-access, area denial defenses in depth and gain the ability to maneuver strategically and operationally over vast distances. The observation made by Major General Heinz Guderian in 1936 on how the strong linear defense in depth of the First World War could be defeated can be applied today on a global scale. "Success is probably attainable," Guderian stated, "only when the entire defensive system can be brought under attack at more or less the same time."<sup>23</sup>

The targets in hyperwar, similar to those of Multi-domain Operations, will become increasingly centered on nodes of systems rather than directly targeting fielded forces.<sup>24</sup> Precise hypersonic missile attacks, coordinated with attacks across all domains, including information, space, and the electromagnetic spectrum, will have simultaneous paralyzing effects on an adversary at all levels - strategic, operational, and tactical. Specific adversary systems could be isolated by meticulous destruction of key nodes, given they can be identified and located. Adversary command and control capabilities and retaliation options could be limited by shaping the integration and synchronization of effects, however significant consideration must be applied to control escalation.

## Summary

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<sup>23</sup> Heinz Guderian, *Achtung-Panzer!: The Development of Armoured Forces Their Tactics and Operational Potential*, trans by Christopher Duffy (London: Brockhampton Press, 1999), 180.

<sup>24</sup> Wesley, interview.

The overarching goal in hyperwar is to achieve simultaneity resulting in adversary paralysis. Operations seek to destroy or neutralize enemy systems with multiple synchronized and simultaneous strikes of hypersonic weapons. The priority is systems rather than forces, in order to first blind the enemy, then eliminate his ability to react, and subsequently protect your own platforms.

## Chapter 5:

### Assessment

The series of startling innovations of the past two decades was assumed to set a pattern for the future; if sufficient funds and ingenuity were applied to any given problem it could be solved; the results of the growing expenditure and scientific talent being applied to military problems could be spectacular; and also (and here came the major source of error) that any improvement in technology would result in a corresponding improvement in the state of the strategic art.<sup>1</sup>

Lawrence Freedman and Jeffrey Michaels  
*The Evolution of Nuclear Strategy*

Numerous studies of U.S. strategic culture show American leaders tend to forgo a long-term strategy in favor of quick engineering fixes and technological solutions. Despite the number of references to Clausewitz in American military literature, Jomini's ideas of simple principles to reduce complexity and ambiguity seem to manifest the most in practice.<sup>2</sup> More often than not, "tactics have masqueraded as strategy" during a time when many Americans believe strategy is obsolete under the umbrella of nuclear weapons.<sup>3</sup>

Hypersonic weapons will be an extremely difficult technology to develop, but they have the potential to create a long-term competitive advantage. One study by RAND noted any nation developing these weapons will need to overcome significant technological challenges in the areas of thermal management and materials, air vehicle and flight controls, propulsion for hypersonic cruise missiles, and hypersonic flight testing, modeling, and simulation to successfully field an operational hypersonic weapon.<sup>4</sup> The critical interconnectedness of each of

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<sup>1</sup> Lawrence Freedman and Jeffrey Michaels, *The Evolution of Nuclear Strategy*, 4<sup>th</sup> ed. (London: Palgrave Macmillan), 195.

<sup>2</sup> Colin Gray, "Strategy in the Nuclear Age: The U.S., 1945-1991," in *The Making of Strategy: Rulers, States, and War*, edited by Williamson Murray, McGregor Knox, and Alvin Bernstein (Cambridge: Cambridge University Press, 1994), 592.

<sup>3</sup> *Ibid.*, 595.

<sup>4</sup> Richard Speier, George Nacouzi, Carrie Lee, and Richard M. Moore, *Hypersonic Missile Nonproliferation: Hindering the Spread of a New Class of Weapons* (RAND Corporation, 2017), 100.

these areas further complicates development. China, Russia, and the United States have shown preliminary success in overcoming these technical hurdles, and it is unlikely other nations will be able to independently do the same in the future.<sup>5</sup>

### Long-Term Competitive Advantage

Nevertheless, the difficult and costly development effort could provide a long-term competitive advantage for the first nation to field an operational hypersonic capability at scale and adapt their military methods to hyperwar. History has shown, the military best able to adopt a revolutionary capability and adjust to the changing character of war has held a position of advantage. Commenting on the advantage hypersonic weapons could provide to U.S. competitors, Karako argues:

The strategic significance is that it [hypersonic weapons] really strikes at the heart of America's place in the world, America's role in the world, especially in terms of power projection. It is unfortunate that the discussion with HGVs is so frequently misunderstood as just a substitute for nuclear ICBMs, when the primary purpose of this is to hold at risk our power projection, our carriers, air bases, and everything else. Russia and China don't have to use these things kinetically against us to change our behavior. They can change our [the U.S.] behavior of a carrier strike group or these other things and that might be good enough for them to win without fighting.<sup>6</sup>

Hypersonic weapons technology creates opportunities for the attacker by reducing an opponent's decision-making ability, negating current defensive systems, denying attribution, expanding the conventional target set, and providing target flexibility. These weapons will impose a cost on any competitor, who will be forced to either accept the position of

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<sup>5</sup> Ibid., 99.

<sup>6</sup> Thomas Karako, interview by Rebecca Heinrichs, *China's Hypersonic Missile Advances and U.S. Defense Responses*, Hudson Institute Video, Mar 11, 2019, <https://www.hudson.org/events/1662-china-s-hypersonic-missile-advances-and-u-s-defense-responses32019>, (accessed February 7, 2020).

disadvantage, or invest in significant tactical innovations to mitigate the multitude of security risks hypersonic weapons present. U.S. strategic leaders appear to believe the nation is in this situation currently.

### Escalation Management

Nations that choose to develop hypersonic weapons should ensure appropriate consideration is applied to prevent miscalculation and inadvertent escalation to nuclear attack. Soon after the United States and Russia suspended obligations to restrict ground-launched ballistic and cruise missiles with a range between 500 and 5,500 kilometers under the INF Treaty, Washington approved the 2020 NDAA containing a new National Missile Defense Policy that underscored the United States will “rely on nuclear deterrence to address more sophisticated and larger quantity near-peer intercontinental missile threats to the homeland of the United States.”<sup>7</sup> Nuclear deterrence experts contend once nuclear parity is achieved between two adversaries, the most stable security environment comes from both sides having invulnerable retaliatory forces.<sup>8</sup> However, conventional hypersonic weapons threaten to provide a way to hold mobile, hardened, and deeply buried nuclear retaliatory forces at risk without putting their own nuclear forces at risk. U.S. strategy must address the possibility of a future strategic environment that is less strategically stable.

The development of hypersonic weapons must be accompanied with credible mechanisms to manage strategic instability. Technological innovation is not always disruptive to stability but it can be if not managed properly.<sup>9</sup> One element of the hyperwar strategy should be

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<sup>7</sup> *National Defense Authorization Act for Fiscal Year 2020*, Public Law 1692, 116<sup>th</sup> Cong., 1<sup>st</sup> sess., (December 20, 2019), 584-585.

<sup>8</sup> Freedman and Michaels, 211.

<sup>9</sup> *Ibid.*, 195.

to field elevated sensors able to detect and track hypersonic weapons from launch. This would allow for the hypersonic weapon attack to be attributed to the originating entity, enable threat warning and attack assessment, and reduce vulnerability to surprise attack. A space-based sensor layer would likely provide the most effective means to restore the United States' extended deterrence posture given the growing complexity of air and missile threats.

Another element of the hyperwar strategy should be the pursuit of technologies to preserve critical decision space for national leadership and implement procedures to reduce strategic attack uncertainties. A 2014 National Research Council assessment underscores how deep uncertainty has historically plagued deterrence planning and decision making, while also stressing how computational and other scientific advances are making considerable technical progress towards clarity.<sup>10</sup> Man-machine teaming could provide the essential ability to accelerate each step of the military decision-making process to ensure relevant and accurate decisions can still be made during hyperwar.

The third element of hyperwar strategy should focus on activities aimed to avoid escalation due to attack ambiguity. Conducting conventional precision strikes deep into an adversary's territory has the potential to be highly escalatory if appropriate mitigation measures are not in place. Specific areas of concern are warhead ambiguity, target ambiguity, and crisis instability. While a rigorous discussion of each issue is beyond the scope of this study, Acton provides a preliminary analysis of each of these areas in chapter five of his study, as well as a key insight that "Conventional Prompt Global Strike (CPGS) weapons would probably

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<sup>10</sup> National Research Council, *U.S. Air Force Strategic Deterrence Analytic Capabilities: An Assessment of Tools, Methods, and Approaches for the 21<sup>st</sup> Century Security Environment* (Washington, DC: The National Academies Press, 2014), 38.

simultaneously enhance deterrence and undermine efforts to manage conflict escalation.”<sup>11</sup> In his study, Acton identifies five characteristics that could mitigate the risk of escalation:

- Separate deployment areas and different trajectories for CPGS and nuclear weapons;
- Boosters with no nuclear association for CPGS;
- Predictable trajectories for CPGS weapons;
- Observable midcourse trajectories for CPGS weapons, and;
- Limited CPGS deployments.<sup>12</sup>

He also points out that the implementation of “inspections, launch notifications, data exchanges, basing restrictions and movement notifications, observation of exercises, and joint studies” could ease Chinese and Russian concerns about U.S. high-precision conventional weapons.<sup>13</sup>

Arms control should also be an essential element of hyperwar strategy to provide another mechanism to manage strategic instability by limiting the proliferation of hypersonic weapons. Unfortunately, efforts in this area will likely prove difficult in the current environment. A 2017 RAND report on hypersonic missile nonproliferation suggested the best way to prevent the spread of hypersonic weapons was to control the export of a “fully integrated weapon, followed by complete subsystems.”<sup>14</sup> However, China shows no interest in entering into arms control agreements and Russia has shown a trend of backsliding on current treaties. Moscow violated the INF Treaty leading to its nullification, and Russian nuclear doctrine and strategy have shown a tendency toward using nuclear weapons in a coercive and military fashion.<sup>15</sup> “We assess that Russia does still remain in compliance with its New START obligations, but its behavior in

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<sup>11</sup> James Acton, *Silver Bullet? Asking the Right Questions About Conventional Prompt Global Strike* (Washington D.C.: Carnegie Endowment for International Peace, 2013), 111.

<sup>12</sup> *Ibid.*, 112.

<sup>13</sup> *Ibid.*

<sup>14</sup> Speier, Nacouzi, Lee, and Moore, 107.

<sup>15</sup> Testimony by Honorable Christopher A. Ford, Foreign Relations Committee, *Countering Russian Intimidation and Aggression and Building a Better Security Environment*, 116<sup>th</sup> Cong., 1<sup>st</sup> sess., December 3, 2019, 2.

connection with most other arms control agreements – and not merely the ill-fated INF Treaty – has been nothing short of appalling.”<sup>16</sup>

### Hyper level of war?

A move towards defining a hyper level of war may help military commanders and planners with the challenge of integrating and synchronizing activities that occur faster than human perception. The broadening of the operational level of war will prove increasingly difficult for a single commander to manage. By defining a hyper level of war, activities, expertise, and resources can be allocated in a more coherent and efficient manner. In reference to the U.S. Army concept of Multi-domain Operations, Wesley argues that you “have to get the right talent and employ training to be thinking in all domains.”<sup>17</sup> Given the concept of hyperwar expands on the ideas of Multi-domain Operations, Wesley’s insight suggests the need to develop specially educated and trained personnel who can focus on this challenge.

### Summary

America must be wary of the pursuit of hypersonic technology at the expense of the strategic art. Hyperwar will require a fundamental change in the way nations fight wars in the future and the possession of hypersonic or nuclear weapons alone will not be enough to secure a national security advantage. The increased chance of miscalculation, operational complexity, and strength of attack that come along with the fielding of hypersonic weapons will require a coherent and comprehensive strategy to mitigate risk.

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<sup>16</sup> Ibid., 2.

<sup>17</sup> Lt Gen Eric Wesley, interviewed by Col (Ret) Daniel Roper, *Special Edition: Multi-Domain Operations-Joint and Allied Integration* (September 30, 2019), [https://www.podbean.com/media/share/pb-g2jms-c1201e?utm\\_campaign=au\\_share\\_ep&utm\\_medium=dlink&utm\\_source=au\\_share](https://www.podbean.com/media/share/pb-g2jms-c1201e?utm_campaign=au_share_ep&utm_medium=dlink&utm_source=au_share) (accessed February 7, 2020).

## **Chapter 6:**

### **Conclusion**

The United States is heavily investing in hypersonic weapons over the next five years without a clear understanding of the revolutionary nature of these weapons, the full strategic implications of this technology, or how the character of war is evolving into hyperwar. This lack of understanding has prevented the United States from developing a well-defined strategy to maintain an advantage in hyperwar. The United States defense leadership has been very clear that the development of hypersonic technology is a priority, however the role these new weapons will have in the overall U.S. defense strategy remains obscure.

The trend in modern wars towards faster tempo warfare, increased weapon standoff, and the militarization of additional warfighting domains combined with the development of weapons with hypersonic speed, global range, maneuverability, and precision strike will provide a revolutionary military capability that will lead to hyperwar. This new form of war will be characterized by diminished strategic deterrence, a broadening of the operational level of war in complexity and scope, and a shift in strength to the offense. At the strategic level, states will be challenged with the threat of surprise attack, compressed decision-making timelines, and increased risk of miscalculation. At the operational level, the demand to integrate and synchronize operations across all domains, including the air, land, maritime, space, and cyberspace domains will drive exponential complexity. Warfare in general will become faster than unaided human perception is able to process and the offense will once again see an advantage to the defense. The use of passive defenses will be essential to protect military capabilities, while active defenses will likely prove technically challenging and expensive to

develop. As humans become the limiting factor in the hyperwar decision cycle, man-machine teaming may be the only way to preserve national level decision space.

Hypersonic weapons will be an extremely difficult technology to develop but have the potential to create a long-term competitive advantage given the risk of escalation can be appropriately managed. The U.S. hyperwar strategy should include elevated sensors able to detect and track hypersonic weapons from launch, the pursuit of technologies to preserve critical decision space for national leadership and procedures to reduce strategic attack uncertainties, activities aimed to avoid escalation due to attack ambiguity, arms control mechanisms, and a move towards defining the hyper level of war.

If past is prologue, the nation best able to adapt their way of war around the revolutionary characteristics in hypersonic weapons will gain an advantage in the next hyperwar. Follow-on research into hypersonic weapons and hyperwar is necessary to inform joint operational concept development, force design, supporting capability identification, and budget prioritization. Additionally, a detailed analysis on escalation control mechanisms should be conducted to identify anticipated capability gaps.

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## Vita

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