The Need for Speed: An Exploration of the U.S. Army Acquisition Strategy for Hypersonic Weapons

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Abstract

Hypersonic missiles are not new to the United States; this technology existed since the late 1940's. Hypersonics is one of the highest modernization priorities in the Army's long range precision fires portfolio in support of multi-domain operations due to adversarial Anti-Access/ Area Denial (A2/AD) threats. However, developing hypersonic technologies with maneuverability, unpredictable trajectories, and high altitude have yet to be achieved. The need for hypersonic speed is imperative with these features for military weapons because of the challenge to defend and detect. Due to the complexity of the technology, hypersonic weapons are also challenging to develop. The United States, Russia, China, and other countries are investing significant resources in Research and Development for these missiles (Chiriac, 2020).

Since 2009, the former Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OSD (AT&L)) funded technology development and flight test demonstrations of hypersonic boost-glide technologies through the Conventional Prompt Strike (CPS) Defense-Wide Account. In July 2018, OSD (AT&L) reorganized and the Office of the Under Secretary of Defense for Research and Engineering OSD (R&E) and the Office of the Under Secretary of Defense for Acquisition and Sustainment OSD (A&S) were established. The OSD (A&S) managed the funding for hypersonic development and OSD (R&E) managed the technology development activities. These technology demonstration activities reached a level of maturity that allows the development of hypersonic weapons based on the OSD-developed glide body design. The Army, as well as other agencies, are developing weapon systems based on this OSD design. The Army must develop an acquisition strategy to deliver this hypersonic capability to the Warfighter (Congress, 2016).

Introduction

Hypersonic systems have been around since World War II. In 1962, when John Glenn Jr, orbited the Earth in Friendship capsule 7, it entered the atmosphere at hypersonic speed. (Boyd, 2022). Hypersonic speed is defined in the Background section. Hypersonic capabilities have advanced throughout history.

> The three X-15 research aircraft flew 199 flights between 1959 and 1968 at speeds up to 2 km/s, providing great knowledge of hypersonic aerodynamics, thermal protection, and reusable aircraft structures. The Apollo reentry capsules, 19 of which launched between 1966 and 1975, achieved reentry speeds of 11 km/s, demonstrating an ability to withstand very high aerothermal loads. The Space Shuttle program, which built five reusable vehicles, launched a total of 135 times, achieved reentry speeds of 8 km/s, demonstrating knowledge of hypersonic aerodynamics and reusable thermal protection. Many of today's interceptor missiles fly in the hypersonic domain at 2–5 km/s, demonstrating advanced guidance, navigation, and control algorithms. The SpaceX Falcon 9 launch system stage separation routinely occurs at ~2 km/s, with the recovery of the first stage demonstrating routine reusable hypersonic flight. (Wie, 2021, para. 6)

Throughout history, several different types of aircraft demonstrated hypersonic speeds. Although the aircrafts traveled at extremely fast speeds, they were not maneuverable.

Background

Missiles and other flying vehicles travel in four regimes of flight speed ranges. The flight regimes are subsonic, transonic, supersonic, and hypersonic. Termed in high regard of the late Australian physicist Ernst Mach, a Mach number is defined as the ratio of the aircraft's speed over the speed of sound. On average, with an air temperature of 32 degrees Fahrenheit, the speed of sound is approximately 760 miles per hour (mph) or 1,223 kilometers per second (km/s). Usually, sound travels faster in warmer air, and when the temperature is at 68 degrees Fahrenheit, the speed of sound is 767 mph (Nelson, 2020). Subsonic vehicles fly less than the speed of sound, usually 250 mph. Aircraft that carry people and cargo fly in subsonic regimes. Transonic vehicles travel near the speed of sound, shifting between 0.8 – 1.3 Mach. Supersonic missiles typically fly between Mach 1 and Mach 5, about 331.3 (m/s) to 1,656.5 (m/s). Hypersonic missiles can travel past Mach 5, or about 1,656.5 (m/s), to 6,957.3 (m/s), which is faster than all other missiles (Speier et al., 2017).

Problem Statement

There is an accelerating push in the United States to acquire hypersonic weapons as evidenced in the FY23 President's Budget (Office of the Under Secretary of Defense (Comptroller), 2022). The United States Department of Defense invests billions of dollars in hypersonic-related activities. Countries like Russia and China have invested billions of dollars in developing hypersonic missiles. The Air Force, Navy, Missile Defense Agency (MDA), Defense Advanced Research Projects Agency (DARPA), and the Army are all developing and demonstrating hypersonic technology. While the Army is developing prototypes utilizing rapid capabilities, there is no validated requirement for a program of record for a hypersonic weapon system (Sayler, 2022). A program of record is a program that holds approved program documentation and is documented in the Future Years Defense Program (FYDP) (DAU, n.d.).

Statement of Purpose and Research Questions

The purpose for this qualitative study is to explore the United States Army Acquisition Strategy for hypersonic missiles.

Research Questions

1. What are hypersonic missiles?

2. Why is there a need for hypersonic missiles?

3. What is the DoD approach for hypersonic missiles?

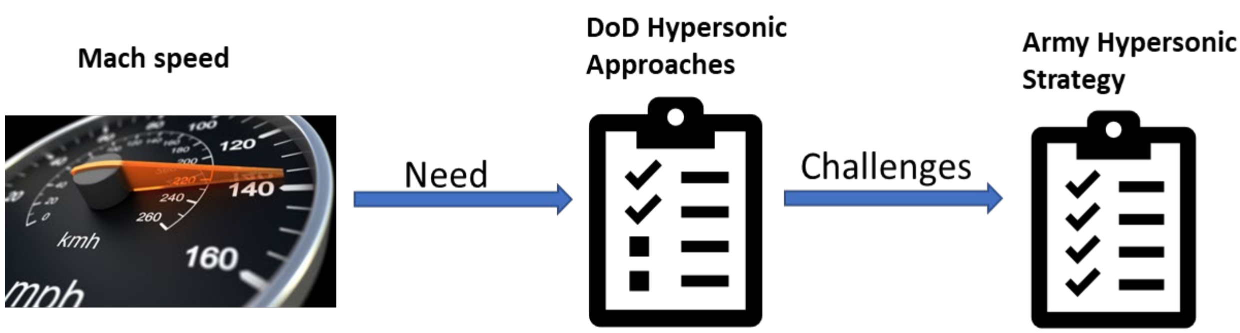
4. What are the Army's challenges to an acquisition strategy for hypersonic missiles?

Conceptual Framework

There is much news surrounding hypersonic weapons about what they are and why they are needed. Rapid capability and delivery of hypersonic weapons to the Warfighter are priorities within U.S. DoD (Office of the Under Secretary of Defense (Comptroller), 2022). The Army must address the acquisition strategy to define the mission requirements, funding, and acquisition management. The researcher provides a visual framework of this study in Figure 1 below. The Army must address these questions to ensure that the appropriate acquisition approach delivers this capability to the Warfighter effectively and expeditiously (2017 National Defense Strategy, 2018).

Figure 1

Research Conceptual Framework



Significance of This Research

An accelerated sense of exigency, provoked by Russia and China, impelled the U.S. DoD to fast-track hypersonic technology development (USCC, 2018). Michael White, the former Under

Secretary of Defense for Research and Engineering, testified to Congress that the United States is not prepared to defend against the attack of China's hypersonic systems that can reach U.S. shores and attack the forces due to the lack of maneuverable weapon systems (Tadjdeh, 2019).

The Rapid Capabilities and Critical Technologies Office (RCCTO) is delivering an experimental prototype Long Range Hypersonic Weapon (LRHW) as part of the Long Range Battalion in support of Multi-Domain Operations. The scheduled delivery of the prototype is by the end of the Fiscal Year (FY) 2023. The management of this weapon system will transition to the Program Executive Office (PEO) Missiles and Space (M&S) in FY2023-FY2024 and become a program of record as it moves through the normal Army acquisition process (RCCTO, 2022).

Overview of the Research Methodology

This study utilized a qualitative research methodology to address the statement of purpose and research questions. The data collection comprised a literature review of the Army's acquisition approach of hypersonic missiles. The research employed key terms to search and exploit several types of materials and databases. Examples of the key terms used were hypersonic missiles, Army hypersonic missiles, and hypersonic weapons. Academic libraries, such as Lawrence Technological University Library, Defense Acquisition University (DAU) Virtual Research Library, National Defense Strategy, Google Scholar, United States Government Accounting Office (GAO), peer-reviewed journals, and defense articles on the World Wide Web yielded literature sources. The researcher reviewed DoD regulations and policies providing guidance and instruction for weapon systems becoming a program of record.

To obtain a scientific definition, the researcher reviewed articles that described the term hypersonic. Researching hypersonic weapons developed within DoD gained a broader perspective. The research examined other countries, such as Russia and China, procuring hypersonic weapons.

Limitations of the Study

This research does not contain formal interviews with Subject Matter Experts (SMEs) or surveys that may have provided different acquisition strategies and plans currently being utilized in the Army and DoD agencies. Additionally, this research is limited to the availability of information on hypersonic missiles in the public domain. This research focuses on the availability of information on hypersonic missiles currently in the FY2023 FYDP.

Summary

There is a sense of urgency within the DoD to develop, produce, and field hypersonic weapons. Russia and China already fielded hypersonic weapons, and both countries are considered global threats (USCC, 2018). The RCCTO is developing and will produce and field the first prototype LRHW battery by the end of FY2023. The Army is collaborating with the other DoD Services to develop the LRHW. There are challenges that the Army must address as it develops acquisition approaches (Roaten, 2022). This research provides an analysis of the acquisition strategy within Army Acquisition.

Literature Review

Introduction

This chapter examines the various types of hypersonic missiles developed or acquired by the U.S. Definitions will also be provided for clarity. The literature review will explore what the other Defense Agencies' acquisition strategies are pursuing in their acquisition of hypersonic missiles. Other countries are discussed to give a global perspective in the pursuit of hypersonic missiles. It is important to note that the U.S. currently does not have any fielded maneuverable hypersonic missiles for strategic missile defense.

Statement of Purpose and Research Questions

The purpose for this qualitative study is to explore the U.S. Army Acquisition Strategy for hypersonic missiles.

Research Questions

1. What are hypersonic missiles?
2. Why is there a need for hypersonic missiles?
3. What is the DoD approach for hypersonic missiles?
4. What are the Army's challenges to an acquisition strategy for hypersonic missiles?

Intercontinental Ballistic Missiles and Non-Intercontinental Ballistic Missiles

It is essential to distinguish between Intercontinental Ballistic Missiles (ICBM)s and non-ICBMs because these are both categories of hypersonic missiles. ICBM is a land-based ballistic missile that travels at least Mach 5 rate. The missile is launched out of the atmosphere and releases nuclear warheads as it reenters Earth onto the target (Gregersen, n.d.). Because of the flight height of ICBMs, these are easy to view with radar or any infrared space surveillance. The trajectory is predictable because it follows a ballistic path under the force of gravity. The non-

IBCMs travel as fast as the ICBMs, but these fly near the Earth's atmosphere due to being launched from a smaller rocket. The unpredictable path makes them maneuverable and challenging to detect (Shillito, 2020). This research will only focus on the non-ICBMs. Therefore, the term hypersonic missile will only reference non-ICBMs going forward. Aero-ballistic, glide vehicles, and cruise missiles are three types of non-ICBMs (Boyd, 2020).

"A hypersonic aero-ballistic system is a warhead that is released from an aircraft, then accelerates to hypersonic speed, and then follows a ballistic, subject to gravity, flight path" (Boyd, 2020, para.10). The United States is not pursuing this type of hypersonic missile because the technology is similar to an ICBM and does not have the modern technology that is being developed currently. It also possesses a nuclear capability, and this technology could provoke our adversaries to launch a nuclear counterattack (Boyd, 2020).

A hypersonic glide vehicle is a warhead that is propelled out of a rocket into the upper atmosphere and, in a maneuverable path, glides to its target at hypersonic speed. Sayler & Woolf (2022) described hypersonic vehicles:

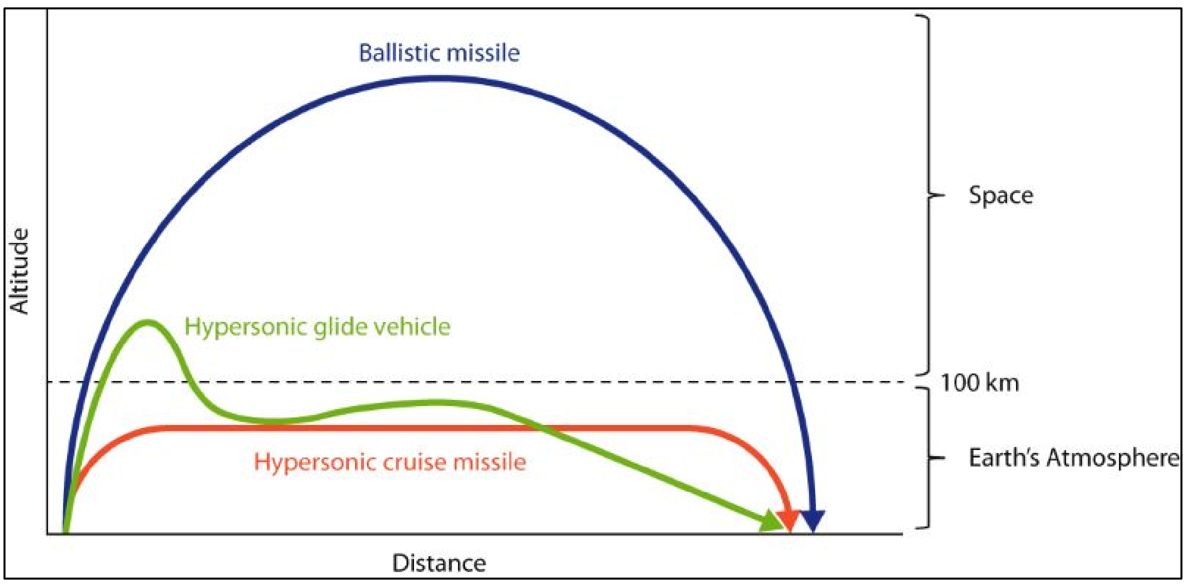
> Hypersonic glide vehicles (HGVs), like all weapons delivered by medium- and longer-range rocket boosters, can travel at speeds of at least Mach 5, or about 1 mile per second. The key difference between missiles armed with HGVs and missiles armed with ballistic reentry vehicles (i.e., those that travel on a ballistic trajectory throughout their flight) is not their speed, but their ability to maneuver and change course after they are released from their rocket boosters. In addition, although it is not necessary, many concepts for the delivery of HGVs presume that the boosters will launch along a flatter, or depressed, trajectory than standard ballistic missiles and will release their gliders at a lower altitude of flight. (p. 1)

Hypersonic cruise missiles reach their target powered by high-speed rocket or scramjet engines utilizing oxygen in the atmosphere for thrust during flight (GAO, 2022). The cruise missiles are proficient in extended, maneuverable hypersonic flight. These travel closer to the Earth and are limited to lower altitudes than hypersonic glide vehicles (GlobalData Thematic Research, 2020).

DoD is pursuing HGVs and cruise missiles (Sayler & Woolf, 2022). Figure 2 visually depicts the different missiles' flight trajectories, projectile motion, and maneuverability.

Figure 2

Flight Trajectories (Aarten, 2020)



Hypersonics within the Department of Defense

The U.S. has been consistently aggressive in researching and developing hypersonic weapons but stopped short of transitioning this capability through the acquisition process to the Warfighter. However, due to Russia’s and China's vigorous pursuit of developing and fielding hypersonic capability in weapon systems, the DoD responded with its own plan for hypersonic weapons.

The DoD developed a three-part strategy to develop and field hypersonic capable systems (Vergun, 2021). The first part concerns fielding offensive hypersonic capability for assaults against time-critical, fortified, high-end systems starting in FY2023. The second focuses on accelerating the development and fielding of a secure system to defend against hypersonic attacks by the late FY2020s. The last part focuses on the capability of reusable hypersonic platforms for on-demand intelligence, surveillance, and reconnaissance (Karako, 2021).

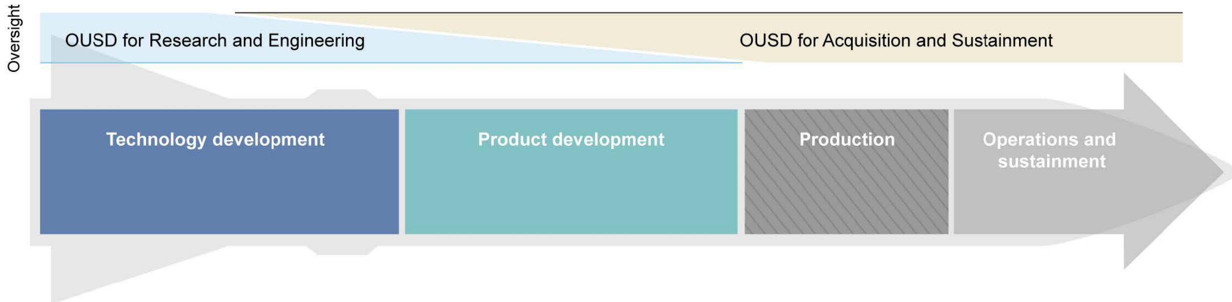
The Office of the Under Secretary of Defense comprises two offices that manage and oversee delivering hypersonic and other advanced capabilities to the Warfighter. These cover technology, acquisition, and sustainment.

> The Office of the Under Secretary of Defense for Research and Engineering (OUSD (R&E)) is generally responsible for overseeing early-phase technology development, including establishing policies on and supervising all aspects of defense research and engineering, technology development, technology transition, prototyping, experimentation, and developmental testing activities and programs, including the allocation of resources for defense research and engineering. (GAO, 2021, p. 5)

As technologies mature and efforts move toward developing integrated weapons systems, the Office of the Secretary of Defense (OSD)-level oversight for them generally moves to the Office of the Under Secretary of Defense for Acquisition and Sustainment (OUSD (A&S)). This organization is responsible for establishing policies on and overseeing all matters relating to acquisition—including (1) system design, development, and production; and (2) procurement of goods and Services—and sustainment (GAO, 2021, p. 5). Figure 3 depicts the oversight of OUSD R&E and OUSD A&S. The two offices work cooperatively to ensure critical capability is delivered to the Warfighter at an expeditious speed to sustain a defensive posture (GAO, 2021).

Figure 3

Office of the Secretary of Defense Level Oversight (Ludwigson, 2021)



OUSD = Office of the Under Secretary of Defense

Source: GAO analysis of Department of Defense data. | GAO-21-378

The Importance of Hypersonic Weapons on DOD's Defense Strategy

Michael White, the Principal Director for Hypersonics in the OUSD (R&E), expounded on the importance of hypersonic weapons on the DoD's defense strategy:

> Our adversaries have a significant inventory of ballistic missiles. They have a significant and are developing a significant inventory of fielded and future hypersonic missiles. And, so if you were in a battlefield timescale environment where they're launching strike packages that take on the order of minutes, and our strike packages take on the order of hours, that's not a timescale that you, you know, that's a timescale asymmetry that we need to make sure we're not – we're not allowing to stand. So, our development of hypersonic systems for the tactical battlefield really is to make sure that we have the ability to compress that, and operate in a compressed battlefield timescale, necessary to deter future conflict. One of the key attributes of hypersonics is it flies very – you can fly

> very high, and you can be maneuverable in flight. So, you're very survivable against even the best air defenses. And so, if you're in a highly contested environment, hypersonic systems give you a degree of lethality that other systems don't give you. You get very long range. So, if you need to really reach out and touch somebody, you know, 1,000, 2,000, even 3,000 nautical miles away, you can do that with a hypersonic system. And our current capabilities don't afford that ability. Our adversaries, our potential adversaries have made that decision. And they have aggressively over the last decade made the decision to move towards hypersonic systems as they field new capabilities. And that's really dramatically compressing that timescale on the battlefield, as I described to you earlier. So that kind of changes the dynamic. We had the luxury before to not move in this direction. We no longer have that luxury. We cannot allow the asymmetry to stand that involves compression of that battlefield time scale. So, we're moving forward (Karako, 2021, pgs. 6-7).

Ray also raised questions about the ability of the Army to find basing options for the weapons. The Army, he said, is trying to "skate right past that brutal reality to check that some of those countries are never going to let you put...stuff like that in their theater.... Just go ask your allies" (Reif, 2021, para. 6).

Some Army officials have also acknowledged the diplomatic challenge associated with basing. “Colonel Jason Charland, a senior Army strategist, told Breaking Defense that it might be that none of our allies and partners in the Pacific want long-range fires on their soil” (Reif, 2021, para. 8).

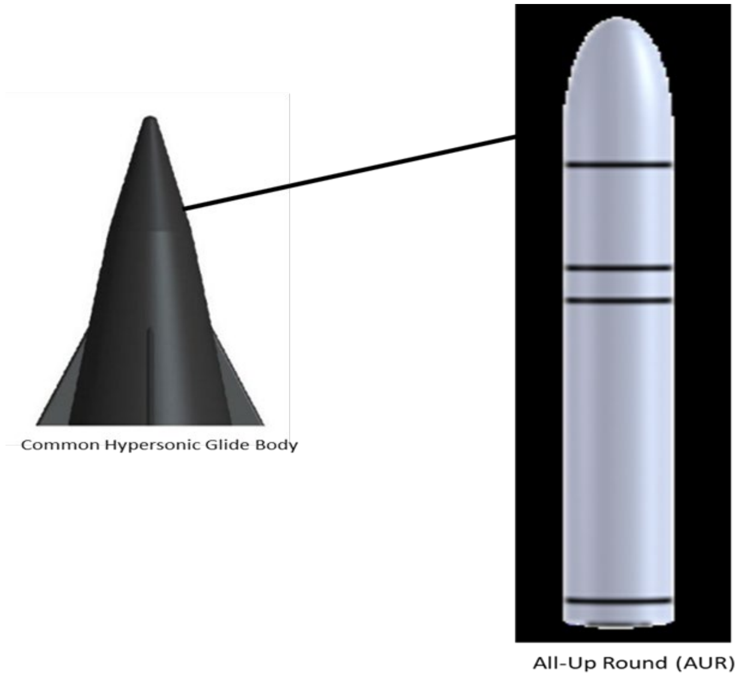
Common Hypersonic Glide Body (C-HGB)

The Air Force, Army, Missile Defense Agency (MDA), and Navy are developing hypersonic weapon systems based on the glide body design called the C-HGB. Collectively, the Services and MDA signed a Memorandum of Agreement (MOA) on August 11, 2019, and are in concurrence to synchronize requirements, technology development milestones, and manufacturing base concerns. Each Service will pursue its corresponding development efforts for continuity in a standard glide body design. The Services and MDA are responsible for independently addressing platform integration. The MOA is set to expire on August 11, 2024 (DoD, 2022).

Figure 4 is a visual depiction of the C-HGB. The C-HGB is designed and developed by the Navy, but the Army produces it. The Army provides the C-HGB to the Navy for integration, and the warhead is fitted with the missile to create the All Up Round (AUR). The RCCTO Director chairs the C-HGB Board of Directors that was established by the MOA (PEO Missiles & Space, 2022). In August 2019, The Army awarded a $351.6 million Other Transaction Authority to Dynetics to develop and deliver the C-HGB system (Jones-Bonbrest, 2019).

Figure 4

Common Hypersonic Glide Body (Jones-Bonbrest, 2019)



The FY2023 President's Budget requests $4.7 billion to support Hypersonic system efforts. The U.S. invested significant funds in hypersonic weapon development and technology across the DoD enterprise. Notable Department investments include an increase in the Army's Long Range Hypersonic Weapon (LRHW) batteries, funding to implement the Air Force's Air-Launched Rapid Response Weapon (ARRW) initial operational capability, and funding for the Navy's Conventional Prompt Strike (CPS) to integrate with DDG 1000 class destroyers as launch platforms (Office of the Under Secretary of Defense (Comptroller), 2022).

Figure 5 depicts the DoD systems in development as of FY2022 with hypersonic-related technology. The Air Force canceled the Hypersonic Conventional Strike Weapon. Of the four remaining programs, DoD will have spent 56% of the $15 billion for hypersonic development efforts from FY2015-2024 (GAO, 2021).

Figure 5

DoD Offensive Hypersonic Weapon Systems (Ludwigson, 2021)

DoD Offensive Hypersonic Weapons in Product Development	Service	Type of Weapon	Description	Acquisition Type
Air-launched Rapid Response Weapon	Air Force	Hypersonic glide vehicle	Seeks to develop a hypersonic glide vehicle carried on a B-52 bomber. The glide vehicle is being developed under the Tactical Boost Glide program in a partnership with the Defense Advanced Research Projects Agency.	Middle-tier acquisition
Conventional Prompt Strike	Navy	Hypersonic glide vehicle	Seeks to develop a hypersonic glide vehicle for underwater submarine launch using the Common Hypersonic Glide Body. The missile system is built jointly with the Army, with the Navy building the missile booster and integrating the missile system.	Middle-tier acquisition
Hypersonic Conventional Strike Weapon	Air Force	Hypersonic glide vehicle	Program cancelled after completing critical design review	Middle-tier acquisition
Long Range Hypersonic Weapon	Army	Hypersonic glide vehicle	Seeks to develop a hypersonic glide vehicle for land launch using the Common Hypersonic Glide Body. The missile system is built jointly with the Navy, with the Army producing the Common Hypersonic Glide Body.	Research and development funds typically reserved for advanced technology or prototypes, rather than major system development
Standard Missile-6 IB	Navy	Rocket propelled missie	Seeks to modify an existing Navy missile, the Standard Missile-6 IA, by integrating a new rocket booster that a DOD official reported will allow it to fly at hypersonic speeds.	Middle-tier acquisition

Hypersonic Attack Cruise Missile (HACM)

In September of 2022, the Air Force awarded a $985 million contract to Raytheon Missiles and Defense for developing, producing, and demonstrating combat capable Hypersonic Attack Cruise Missile (HACM) prototypes. The HACM is an “air-launched, scram-jet powered hypersonic weapon designed to hold high-value targets at risk in contested environments from stand-off distances.” (Secretary of the Air Force Public Affairs, 2022, para. 2). The HACM capability is scheduled to be delivered by FY2027 (Secretary of the Air Force Public Affairs, 2022).

Conventional Prompt Strike (CPS)

The CPS is the Navy’s hypersonic missile. CPS is a conventional, boost-glide hypersonic weapon system. The CPS all-up-round missile includes a two-stage solid rocket motor booster and a Common Hypersonic Glide Body (C-HGB) containing a kinetic energy projectile warhead. The Navy intends to launch CPS from Zumwalt-class surface combatants and Virginia-class submarines to attack high-value and time-sensitive targets. The Navy’s CPS acquisition strategy is designed to develop fieldable prototypes and transition to production in three phases. Phase 1 is a Middle Tier of Acquisition Rapid Prototyping program intended to develop and demonstrate a prototype cold-gas launched hypersonic missile system (DOT&E, 2021).

Phase 2 is a Middle Tier of Acquisition Rapid Fielding program intended to field the hypersonic missile system onboard a Zumwalt-class surface combatant. Phase 3 intends to transition the program to a Major Defense Acquisition Program at Milestone C with the intent to conduct Initial Operational Test & Evaluation (IOT&E) and field the hypersonic missile system onboard the remaining Zumwalt-class combatants and Virginia-class submarines (Director, Operational Test and Evaluation (DOT&E, 2022, p. 140).

In February 2019, Lockheed Martin was awarded an $846 million contract for the design, development, build, and integration of large diameter rocket motors, associated missile body flight articles, and related support equipment for CPS test demonstrations. This was a preliminary step towards developing the hypersonic glide weapon body for all the Services by 2025 (Kay, 2021, para. 4).

The Navy also awarded Lockheed Martin a $1.54 billion modification contract in March 2021 to design, build, test, and integrate the system. The Navy is requesting $1.2 billion for CPS Research, Development, Test, and Evaluation (RDT&E) in FY2023 - a decrease of $169 million from the FY2022 request and $120 million from the FY2022 appropriation (Sayler, 2022, p. 6).

The Air to Ground Missile (AGM)-183 Air-Launched Rapid Response Weapon (ARRW)

The ARRW is an Air Force hypersonic boost-glide vehicle containing a kinetic energy warhead that glides to its target. ARRW is designed to enable the U.S. to hold fixed, high-value, time-sensitive targets at risk in contested environments from stand-off distances from a bomber aircraft platform. The Air Force awarded a $480 million contract to Lockheed Martin to develop the prototype. “It will also expand precision-strike capabilities by enabling rapid response strikes against heavily defended land targets” (Secretary of Air Force Public Affairs, 2022, para. 6). The FY2023 President’s budget included approximately $47 million dollars for AARW in procurement. However, the Air Force will transfer this procurement funding to RDTE to focus more on development and testing. The Air Force is also considering pursuing the effort for the weapon system to become a program of record (Insinna, 2022).

The Hypersonic Conventional Strike Weapon (HCSW)

The Air Force canceled the Hypersonic Conventional Strike Weapon (HCSW) program was canceled after the Critical Design Review in the spring of 2020.

> This milestone was initially scheduled for the third quarter of 2019. The U.S. Air Force issued a termination for convenience notice to Lockheed’s Space division on 10 February 2020. Designed to be launched from a B-52, the Aerojet Rocketdyne-boosted HCSW was the first of five hypersonic missile prototype projects that have entered development since 2018. It featured a “front end” derived from the Common Hypersonic Glide Body. The HCSW program's objective was to design, develop and integrate an air-launched hypersonic conventional strike weapon on both fighter and bomber aircraft platforms (Pike, n.d., para. 1).

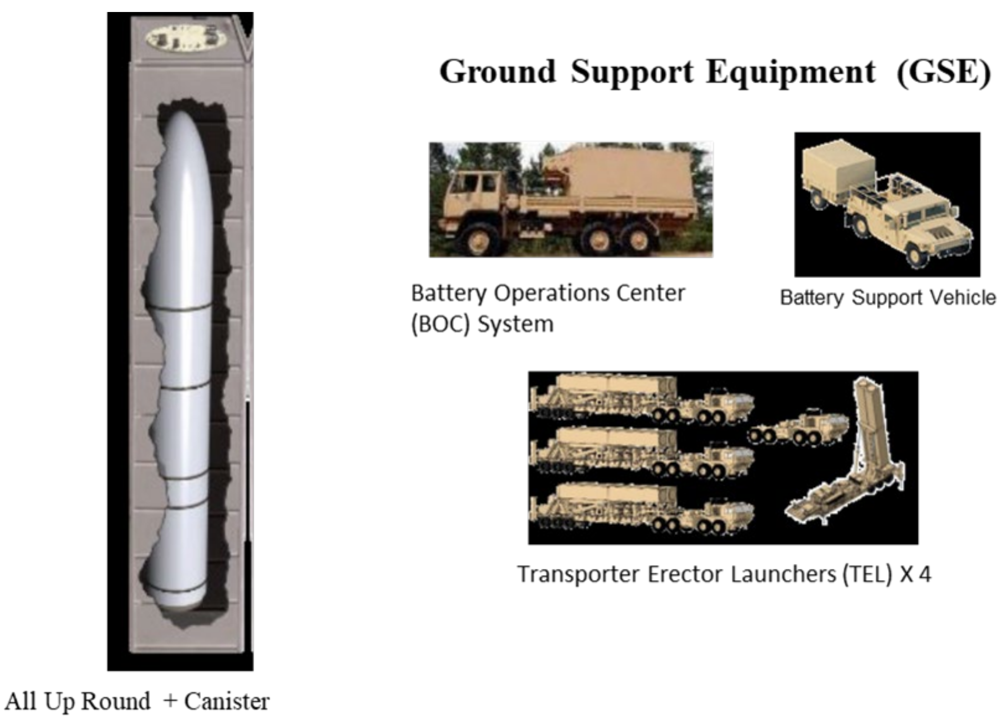
Long Range Hypersonic Weapon (LRHW)

The U.S. Army is developing a hypersonic glide body missile system called Long-Range Hypersonic Weapon (LRHW). The prototype LRHW system will be delivered with residual military capability by the end of FY2023 (RCCTO, 2019). The LRHW is part of the Army's strategic long-range precision fires portfolio which is one of the Army's six modernization priorities within the Army's Modernization Strategy. The Army’s six priorities are long range precision fires, next generation combat vehicles, future vertical lift, network, air and missile defense, and soldier lethality (Army, 2019).

The LRHW consists of the Common Hypersonic Glide Body (C-HGB) and the Navy 34.5-inch booster. The LRHW system, as depicted in Figure 6. consists of four Transporter Erector Launcher (TEL) vehicles, and each TEL vehicle will carry two All Up Round plus Canister (AUR+C). One Battery Operations Center (BOC) system and battery support vehicles are part of the Ground Support Equipment (GSE) for the LRHW. The Army manages the contract for the production of the C-HGB under the Navy Design Authority. The Navy receives the C-HGB as Government Furnished Equipment from the Army and integrates it with the booster and the Canister to produce the AUR+C. The system is projected to have a range of over 1,725 miles (PEO M&S, 2022).

Figure 6

Long Range Hypersonic Weapon System (RCCTO, 2022)



In FY2022, the Army conducted an unsuccessful system flight test of the prototype called the Joint Flight Campaign 1 (JFC1) flight test. However, the Army is planning two additional tests, JFC-2 and JFC-3. Following the flight tests, the plan is to field the experimental prototype by the end of FY2023 (Everstine, 2022). In FY2023, the Army requested $806 million in RDT&E for the LRHW system. The requested amount yielded $380 million more than the FY2022 appropriation. In FY2023, the Army also requested $249 million in procurement dollars for ground support equipment (Sayler, 2022). The Army plans to field three full batteries of the LRHW missiles (Everstine, 2022).

Hypersonic missiles in other countries

Russia possesses hypersonic weapon programs, including the Avangard, 3M22 Tsirkon, and the Kh-47M2 Kinzhal. The Avangard is a hypersonic boost-glide vehicle with nuclear capability. The Tsirkon is a hypersonic cruise missile designed to hit the ground and naval targets from a ship or submarine. The Kinzhal is a ballistic missile that maneuvers when it is air-launched (Sayler, 2022). Reportedly, Russia launched a Kinzhal missile at a munition's depot in Ukraine on March 19, 2022 (Dahlgren & Shaikh, 2022).

China is also investing in hypersonic weapons, and it is reported that they have fielded the Dongfeng (DF)-17 and the DF-41. The DF-17 is a hypersonic glide vehicle that may equip nuclear warheads (Shaikh et al., 2021). The DF-41 is an ICBM that can carry multiple independently targetable warheads. The DF-41 is road-mobile and is launched from an eight-axle TEL (Missile Defense Project, 2021). "It is reported to be one of the deadliest ICBMs in the world and is a nuclear threat to the U.S. mainland" (Arg, 2022, para. 1).

Other countries are investing in hypersonic weapon technology, such as Australia, India, Japan, France, and Germany. India and France have advanced technology while Australia, Germany, and Japan are pursuing Research and Development programs (Yeo, et al, 2022).

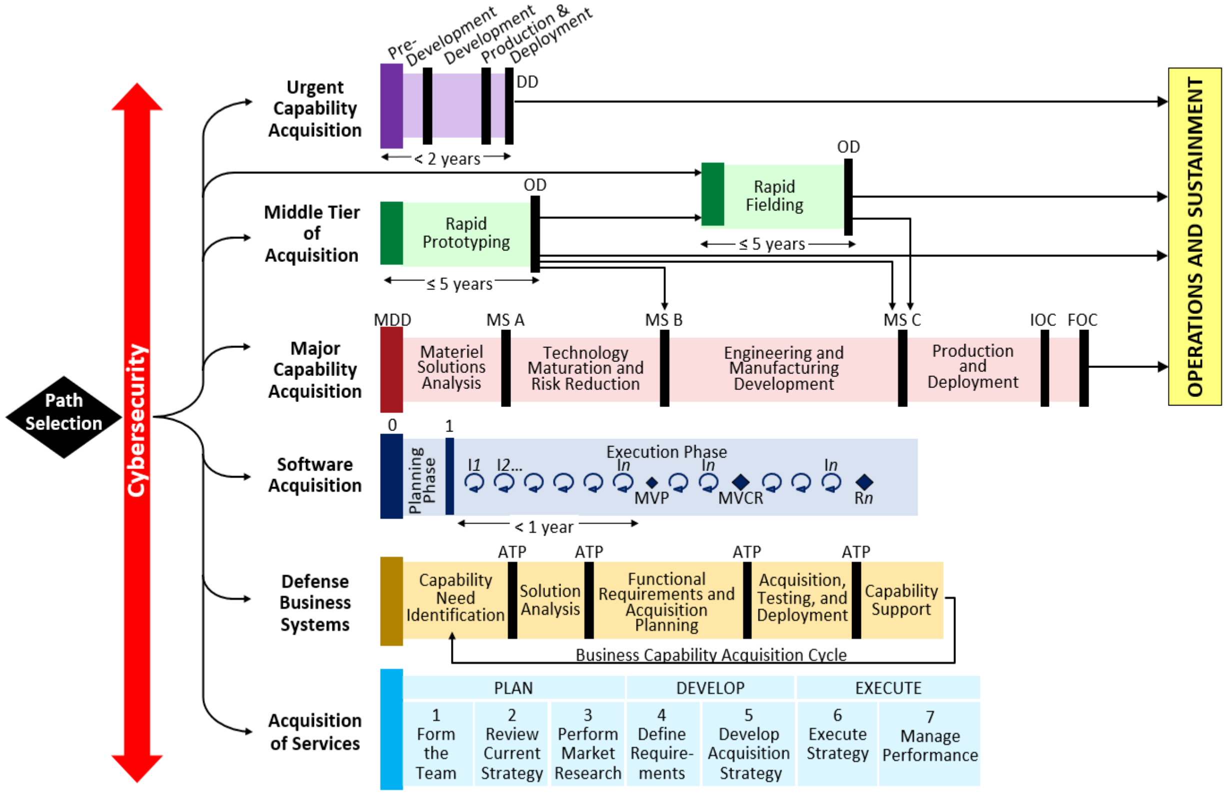
Adaptive Acquisition Framework (AAF).

The AAF allows the Program Manager to develop an acquisition strategy by exercising one or more of six pathways. The six pathways are Urgent Capability Acquisition (UCA), Middle Tier of Acquisition (MTA), Major Capability Acquisition, Acquisition of Services, Defense Business Systems, and Software Acquisition. The Acquisition of Services pathway is for procuring Services and not weapons systems. The Defense Business Systems pathway is to acquire business systems and not weapon systems. The Software Acquisition pathway is to deliver software capability. Without an Urgent Operational Need Statement that will allow the use of the UCA, the only two options for an accelerated acquisition strategy are the Major Capability Acquisition and MTA (OUSD A&S, 2020).

The AAF referenced in Figure 7 supports the Defense Acquisition System intending to promptly deliver practical, suitable, survivable, sustainable, and affordable solutions to the end user. To achieve those objectives, Milestone Decision Authorities (MDAs), other Decision Authorities, and PMs have broad authority to plan and manage their programs consistent with sound business practices.

Figure 7

Adaptive Acquisition Framework (OUSD A&S, 2020)



The AAF acquisition pathways provide opportunities for Milestone Decision Authorities and PMs to develop acquisition strategies and employ acquisition processes that match the characteristics of the capability being acquired. (OUSD A&S, 2020, para. 3).

The Navy and the Air Force entered the middle-tier acquisition (MTA) pathways for their hypersonic efforts. DoD Instruction 5000.80, Operation of the Middle Tier Acquisition (MTA), establishes a policy for rapid prototyping and rapid fielding. OUSD(A&S) is responsible for prototyping efforts in collaboration with OUSD (R&E). The MTA pathway allows the use of advanced technologies to precipitously develop prototypes with fielded capability. It provides an avenue for new capabilities that have been demonstrated in an operational environment to be fielded within five years of the pathway start date (OUSD R&E, 2022).

The Army utilized the Other Transaction (OT) Authority under 10 U.S. Code, Section 2371b – The Authority of the Department of Defense to carry out certain prototype projects. The OT Authority agreements are legally binding vehicles that provide the DoD with increased flexibility for conducting research and prototyping projects with the commercial industry. These are not subject to the Federal Acquisition Regulation (FAR) that is applicable to traditional government contracts. These can be executed faster due to not adhering to the laws and regulations required by FAR-based contracts (OUSD R&E, 2022).

Rapid Capabilities and Critical Technologies Office (RCCTO)

The RCCTO serves to expedite technology and capability to enable the Army's implementation of the National Defense Strategy. The Office enables the Army to research, develop, prototype, procure, transition, and field technologies in real time to address urgent and emerging threats while supporting acquisition reform efforts. The RCCTO reports to a Board of Directors led by the Secretary of the Army, including the Chief of Staff of the Army, Secretary of the Army, Vice Chief of Staff of the Army, Army Acquisition Executive, and the Commander of Army Futures Command (RCCTO, n.d, p. 2). The RCCTO Director serves as the Decision Authority for the LRHW prototype, Battery 1 and the office is responsible for fielding the residual combat capability (RCCTO, n.d.).

Acquisition Strategy

The Acquisition Strategy is the Program Manager's (PM) approach to meeting cost, schedule, and performance objectives. The FAR directs the PM to develop an acquisition strategy specifically designed for the major weapon program. The Federal Acquisition Regulation (FAR) defines the strategy as "the program manager's overall plan for satisfying the mission need in the most effective, economical, and timely manner" (Secretary of Defense, et al., para. 34).

Transition Planning

There are some prototype programs that will transition into an acquisition program that is subjected to the FAR and the Joint Capabilities Integration and Development process, which documents the need for new capabilities. Transition planning should start at the onset, if the initial plan is to transition the prototype program into an AAF pathway. Coordination is "prudent to begin planning and coordinating the transition as early as possible with appropriate DoD and Military Services process owners and drafting the appropriate artifacts required by traditional acquisition processes" (OUSD R&E, 2022, p. 20-21).

Transition plans "should include, as appropriate, the transition approach, the transition partner, supportability requirements, data rights, funding approach, and specific testing or demonstration criteria required by the transition partner" (OUSD R&E, 2022, p. 21). The plan should be synergized between the two offices from beginning to the end of the transition.

Best Practices for Transitioning Prototypes

The following best practices were recommended for transitioning prototypes:

• Make the transition plan an important factor during project initial selection. Proposals where the transition partner is an active part of the team before award are much more likely to transition when the prototype is completed.

• Ensure the transition partner is appropriate for the type of prototype. For example, a technology or prototype sub-component that fits into a currently-fielded system needs to transition to the acquisition office in charge of that system, not a Combatant Command or Service lab.

• PMs that transition prototypes to operational use or rapid fielding should ensure the capability is safe for the Warfighter, suitable for the mission, and supportable.

• Establish a configuration baseline (e.g., level 2 drawings) for prototypes that transition to rapid fielding (OUSD R&E, 2022, p. 21).

Summary

The literature review provided an overview of hypersonic weapons, the Army and other agencies within the DoD developing them, and other countries developing hypersonic weapons. It also provided an analysis of the Services' role of the C-HGB. The review also identified the acquisition strategy for the hypersonic weapon systems that are currently in development and the creation of the MOA between the Services and MDA. The review provided the amount of funds DoD invested in developing these hypersonic weapons.

Research Methodology

Statement of Purpose and Research Questions

The purpose for this qualitative study is to explore the United States Army Acquisition Strategy for hypersonic missiles.

Research Questions

1. What are hypersonic missiles?
2. Why is there a need for hypersonic missiles?
3. What is the DoD approach for hypersonic missiles?
4. What are the Army's challenges to an acquisition strategy for hypersonic missiles?

Research Methodology

The research paper focuses on the various types of hypersonic missiles in the Department of Defense currently in development. The research methodology utilized in this research is to explore how the Army will utilize the acquisition process to deliver hypersonic missiles to the Warfighter. The researcher conducted a qualitative analysis of different acquisition strategies and the Army processes for acquiring weapon systems. Qualitative analysis is a method to comprehend and investigate without imposing one's views and not forming a collaboration of opinions from the analysis (Creswell and Guetterman, 2019)

The researcher reviewed literature that described hypersonic weapons across DoD that had systems in development. The researcher looked at 70 efforts with technology development for hypersonic weapons and narrowed the list down to offensive hypersonic weapons within DoD. Department of Energy, National Aeronautical and Space Administration (NASA), Defense Advanced Research Projects Agency (DARPA), and Missile Defense Agency (MDA) were also reviewed.

This researcher explored hypersonic missiles within the Department of Defense and the progress within countries worldwide. The researcher also reviewed the Adaptive Acquisition Framework pathways DoD is using to acquire hypersonic missiles. A review of RCCTO explored the LRHW prototype system under a tailored acquisition streamlined process.

Hypersonic weapons in the literature were reviewed and compared to establish similarities and challenges. Non-ICBMs and ICBMs were researched to understand the differences and impacts. The researcher compared the acquisition strategies of the DoD's hypersonic weapons to determine the efforts and progress implemented across the DoD.

Data Collection

The researcher conducted a qualitative review of DoD, Army, and other government published reports. Research explored offensive hypersonic weapons, hypersonic missiles, and hypersonic missiles within DoD as key search terms. DoD budget reports, Congressional Research Reports, U.S. Government Accountability Office reports, and congressional testimonies guided the review. Various scientific documents garnered an understanding of Mach speeds.

Validity of the Research

The researcher reviewed sourced documents and discovered informative materials from several internet search engines. Sources primarily from the United States Government, the Department of Defense, and published reports that addressed DoD and Army hypersonic weapons were utilized to ensure the high validity of the research. DoD policies contributed to the research. The documents examined in the research were reviewed and compared for consistency.

Limitations of Study

The availability of published information limited the study. This research was also restricted to the hypersonic weapons currently in development and currently in the FY2023 President's Budget. The paper does not include classified information addressing hypersonic weapon capabilities.

Summary

This section included the researcher’s methodology in gaining an understanding to address the research questions. Data collection and limitations of this research were explained. Various published literature documents were reviewed, and interviews and surveys were excluded from the research. The information derived from the research is provided in the findings section.

Findings

Introduction

This chapter will analyze the information presented in the literature review and will present findings. The definitions, policies, acquisition strategies, LRHW, and other hypersonic weapons within DoD will be reviewed in this chapter. The findings will identify the strategies utilized today that the Army can leverage for the LRHW to become a program of record when it transitions from RCCTO.

Statement of Purpose

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Research Questions

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Need for Hypersonic Weapons

The Army requires the capability to engage time-sensitive, militarily significant, and materiel point and area targets at strategic ranges in weather conditions identified during the RCCTO LRHW prototype effort to result in lethal effects. Additionally, the LRHW provides the Army with the means to suppress, delay or destroy ground and maritime targets that immediately impact the battle, destroying or neutralizing the enemy's ability and will to continue the conflict. LRHW complements other attack assets to include cruise missiles and both manned and unmanned aircraft, especially in those cases where the other assets are unable or unavailable to attack targets in a timely fashion (Fires Center of Excellence, 2019).

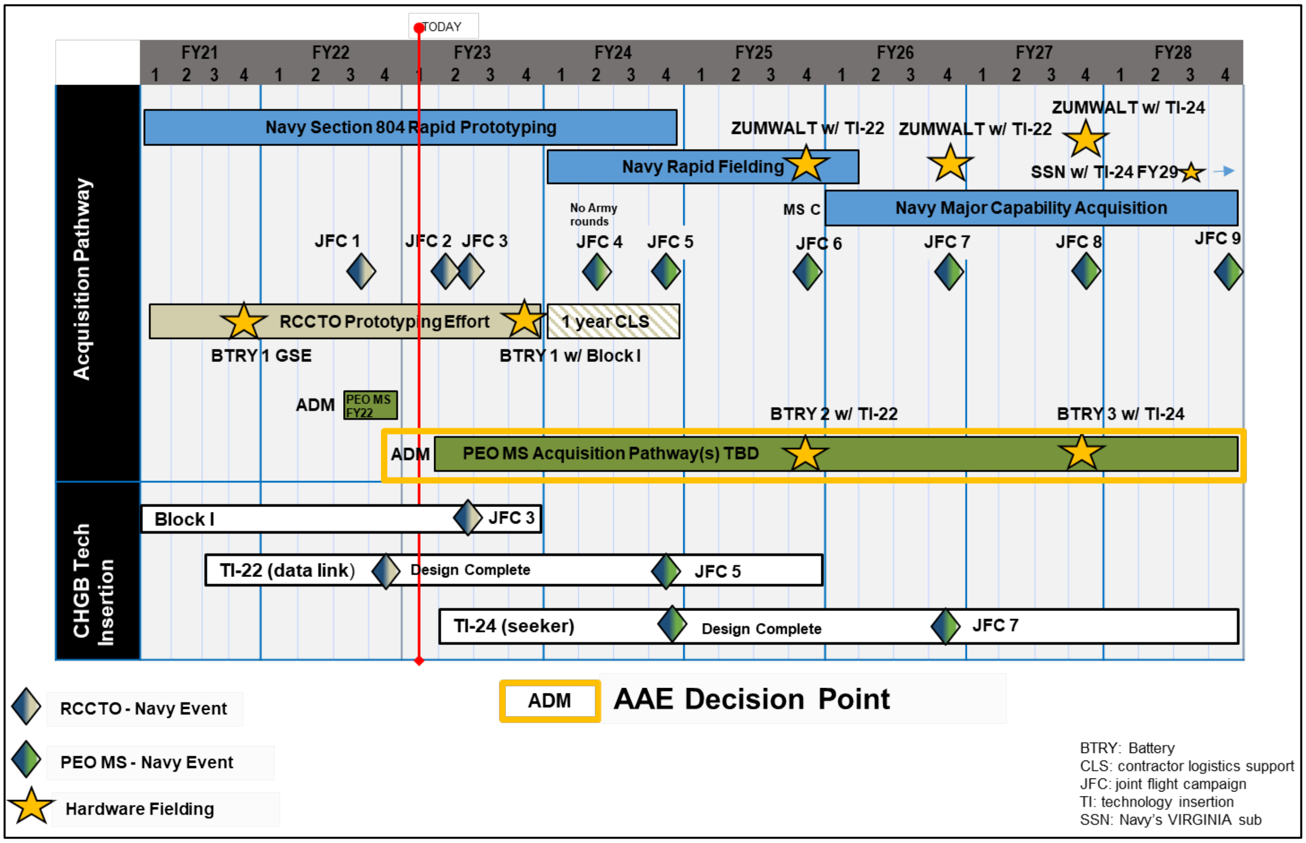
LRHW Prototype Missile

The RCCTO program office manages the LRHW activities. The RCCTO was established in 2018 to improve the speed of technology and capability delivery to the Warfighter. For hypersonics, the office is responsible for rapidly developing the LRHW prototype to deliver a combat-capable system to the Warfighters. The Army RCCTO Director is the Decision Authority for the LRHW prototype. By the fourth quarter of FY2023, the RCCTO office is scheduled to deliver an experimental prototype LRHW system that is combat-ready. This initial prototype is considered Battery 1. After the fielding of the prototype, RCCTO will transition LRHW to PEO Missiles and Space for a program of record. PEO Missiles and Space will field two additional batteries by the end of FY2027 (Sayler, 2022).

In the FY2023-27 Program Objective Memorandum, the Army programmed approximately $5.9 billion in RDT&E and Procurement funds. The Army programmed approximately $235.7 million to RCCTO for Battery 1. The Army programmed $240.9M million in Missile Procurement funds to procure ground support equipment to support the fielding of Battery 2 in the fourth quarter of FY2025. The planned testing for Battery 1 includes three Joint Flight Campaigns. The Joint Flight Campaigns are flight tests conducted by the Army and the Navy to demonstrate capabilities and provide test data. This test will be the first Joint test flight of the hypersonic missile. There will be two follow-on tests to assess the missile launch from the Army TEL. The JFC-3 and the final testing report for the JFC-2 were scheduled for the second quarter of FY2023. This date is approximately six months after the planned contract award for ground support production (PEO Missiles & Space, 2022).

Figure 8

Long Range Hypersonic Weapon Schedule (PEO Missiles & Space, 2022)



The schedule above, in Figure 8, depicts the priority for the accelerated fielding of the LRHW capability. Before JFC-2 and JFC-3 are completed to assess the missile launch, a contract award for the ground support equipment began in fourth quarter FY2021 (PEO Missiles & Space, 2022). PEO M&S must receive an Acquisition Decision Memorandum (ADM) from the Army Acquisition Executive (AAE) in order to proceed with execution of an acquisition strategy.

Challenges of defining an acquisition strategy for LRHW

GAO evaluated DoD's efforts to develop hypersonic systems. GAO's analysis of other programs shows that producing the product before critical technologies fully mature increases the risk that programs encounter obstacles, such as schedule delays, funding shortfalls, or failure to reach objectives (GAO, 2021).

The FY2021 DOT&E Annual Report concluded the LRHW program still needed to define the testing and evaluation strategy to determine residual combat or initial operational capability. In addition, more testing data were needed to evaluate the residual combat capabilities of the LRHW. Although some testing data was available, it was not sufficient to evaluate the capability's effectiveness, suitability, or survivability (DOT&E, 2022, p. 87).

Figure 9

FY2023 DoD Hypersonic Weapons RDT&E and Procurement Funding (Office of the Under Secretary of Defense (Comptroller), 2022)

Research, Development, Test & Evaluation, Advanced Component Development & Prototypes (ACD&P), Procurement							**Date: April 2022**		
COST ($ in Millions)	**Service**	**Appropriation**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**Total Cost**
643882: *Air-Launched Rapid Response Weapon (ARRW)* Prototyping	Air Force	RDT&E	318.687	114.981	0.000	0.000	0.000	0.000	808.094
ARRW00: *Air-Launched Rapid Response Weapon (ARRW)* Procurement	Air Force	Procurement	0.000	46.566	0.000	0.000	0.000	0.000	46.566
PE 0604183F / Hypersonics Prototyping - Hypersonic Attack Cruise Missile (HACM)	Air Force	RDT&E	190.116	144.891	0.000	0.000	0.000	0.000	335.007
643883: *Hypersonic Attack Cruise Missile* Prototyping (HACM)	Air Force	RDT&E	0.000	316.887	270.240	305.602	237.367	105.990	1236.086
0605232A LRHW EMD	Army	RDT&E	111473	633.499	944.768	940.402	422.581	420.219	114834.469
0604182A Prototype Hypersonic	Army	RDT&E	315.131	173.168	43.244	28.014	0.000	0.000	559.557
0605518N Conventional Prompt Strike (CPS)	Navy	RDT&E	1325.232	1205.041	1286.159	1531.412	1603.114	1094.103	8045.061
947 CPS - Procurement	Navy	Procurement	0.000	178.877	178.203	154.421	33.198	21.084	565.783
0604786N Offensive Anti-Surface Warfare Weapon Development	Navy	RDT&E	70.792	124.204	98.480	102.464	86.334	87.652	569.926

As depicted in Figure 9, the Department of Defense FY2022 budget progressively shows significant increases in hypersonic weapons RDT&E funding. The Navy received approximately $1.4 billion for CPS, and the Army received about $112 million for LRHW prototype Battery 1.

For FY2023, The DoD requested $4.7 billion to support hypersonic development efforts. The Army increased the FY2023 requests to $634 million. The increase in funding demonstrates a growing priority placed on fielding the residual combat capability and maintaining the momentum of the Army's priorities (Office of the Under Secretary of Defense (Comptroller), 2022).

The MOA among the Services for Hypersonic Boost Glide Technology Development provides the basis for the current activities to develop the LRHW. When LRHW transitions from RCCTO to PEO Missiles and Space, technology insertions will continue as it goes from a prototype to become a program of record (Feickert, 2022). Army's LRHW effort is linked to the Navy's Conventional Prompt Strike Program by the C-HGB whose missile parts are mutually developed and produced by the Navy and Army. The missile components are the same. However, the canister will be different for the Army and the Navy (PEO Missiles & Space, 2022). The Army produces the C-HGB under Navy Design Authority, and the Army procures AUR+C from the Navy. Any delay in funding or schedule for either Army or Navy will impact the production of the AUR+C.

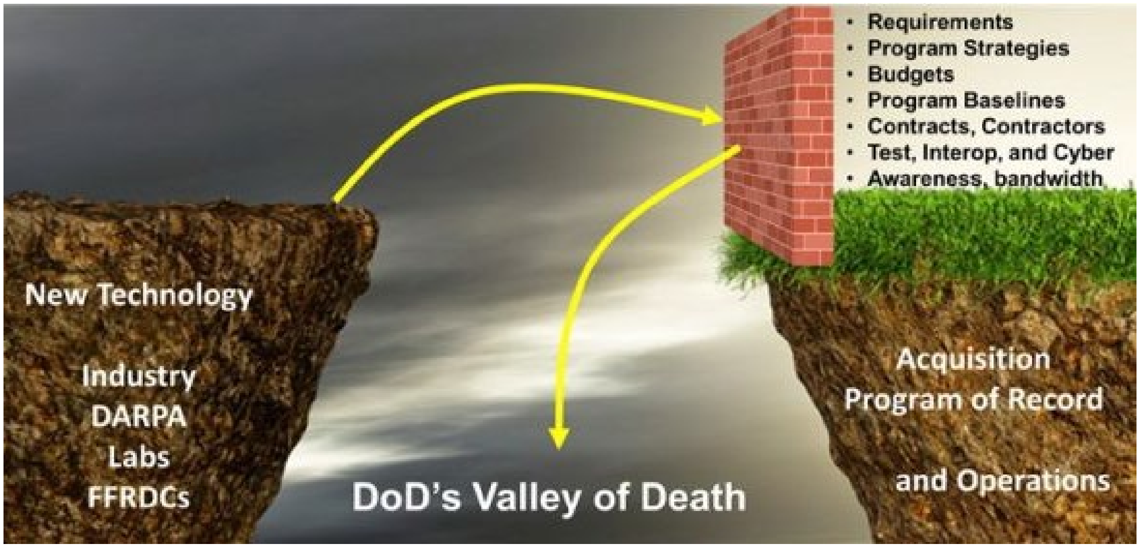
The Army still needs to enter a DoD AAF pathway for the initial LRHW prototype. The FY2016 National Defense Authorization Act created the Middle Tier of Acquisition (MTA). MTA is a streamlined acquisition process to acquire critical capabilities at an expeditious rate. In 2018, OUSD (A&S) and United States Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASA(ALT)) published interim MTA policies. The Army began using the MTA authority in 2018. In January 2020, DoD codified the six AAF pathways available for acquiring a capability in DoD instruction 5000.02. The instruction states that project managers will establish an acquisition strategy that aligns with the AAF pathway and associated processes, complexity, and peculiarity of the system being procured (OUSD A&S, 2020).

The Air Force and Navy entered MTA rapid prototyping pathways for their hypersonic efforts. The Army is the only Military Service that did not selected a pathway for hypersonic efforts. Although the LRHW meets the criteria, the RCCTO did not utilize the MTA, Major Capability Acquisition pathway, or any other pathway under the DoD AAF. Instead, it developed Battery 1 prototype using an OT Authority. This authorized RCCTO to obligate funds under the 10 U.S. Code, Section 4022. RCCTO's charter gave its executive director the authority to request waivers to deviate from Army policies through the RCCTO board of directors and appropriate authorities outside the Army (RCCTO, n.d.).

As depicted in Figure 10," the "valley of death" is the gap between technology development and an acquisition program of record where potential technologies end because of lack or insufficient funding" (OUSD R&E, 2022, p. 21). The technology community that develops technology relies on prototype demonstration, and the PEO or program office depends on firm requirements (OUSD R&E, 2022). Collaboration and extensive communication between the two can assist in bridging the gap ensuring the required funding and resources are identified to implement a smooth transition.

Figure 10

DoD's Valley of Death (Modigiliani, 2022)



Summary

This chapter presented challenges for the Army in defining an acquisition strategy based on analysis of the literature review. This analysis provided examples of those challenges. A summary is provided in the following two paragraphs for added emphasis.

PEO M&S needs an approved ADM by the AAE to execute the appropriate AAF pathway for the LRHW Battery 2 and 3. The ADM provides cost, schedule, performance, thresholds, and objectives to manage the program of record for LRHW. The Army is tied to the performance and the production of the C-HGB with the Navy. If there are any delays in the Navy's schedule or funding, then it will impact the Army. Due to limited testing, DOT&E has not been able to evaluate the residual combat capabilities of the LRHW (DOT&E, 2022). There are questions concerning the rationale of the Army producing hypersonic missiles given the cost of the system and that the Air Force is producing similar capability.

The Army funded the RDT&E efforts for the LRHW weapon system. The LRHW system is now under RCCTO and will transition to PEO Missiles & Space when the prototype is a residual combat-ready unit. The RCCTO did not select a pathway for the prototype LRHW; instead, it utilized an OTA for the contracting effort. To comply with DoD acquisition policy, PEO Missiles & Space will have to seek AAE approval to enter the MTA rapid fielding pathway to field the LRHW Batteries 2 & 3 (PEO Missiles & Space, 2022). To obligate and expend appropriated funds, PEO Missiles & Space must have an ADM.

When the system transitions to the PEO Missiles and Space, establishing a program of record could be challenging if the technology or funding is not where it needs to be. There is a threat of the capability ending in the valley of death if the technology has not reached the desired level of maturity. This will prohibit PEO Missiles and Space from utilizing the MTA Rapid Fielding pathway. The next chapter will provide conclusions, a recommendation, and additional research, based on research findings.

Conclusions and Recommendations

Introduction

This chapter entails a conclusion based on the research questions, findings, and analysis. Research questions and areas for future research will be expounded, and a summary will conclude this chapter.

Conclusions

The following are seven conclusions:

1. Although not a joint program, the LRHW missile is a weapon that is managed by the Army; however, the missile design is managed by the Navy. The Army will use a common glide vehicle with the Navy's booster system. Due to it being hypersonic, the system is intended to fly five times the speed of sound with a range of more than 1,725 miles. The Navy is responsible for producing the missile booster and the overall integration of the missile with the C-HGB developed by the Army to deliver an AUR for platform integration by the Army and the Navy. Each Service will be responsible for the platform integration and address any unique design, build, and test efforts (RCCTO, 2022).

2. The LRHW acquisition approach uses RCCTO RDT&E funds to deliver the first prototype, Battery 1, to the Warfighters by the end of FY2023. The effort will transition to PEO M&S to field Battery 2 and 3. When the program transitions for a program of record, an ADM is required for PEO Missiles & Space to expend the funds required for production and stay on the planned delivery schedule. The program is scheduled to be transitioned from RCCTO to PEO Missiles and Space in FY2023.

3. According to DOT&E, the LRHW program does not have a Test and Evaluation strategy required for Initial Operations Capability (IOC) to demonstrate residual combat capability. The intent is that residual combat capability will be achieved by Battery 1, and IOC will be achieved by Battery 2 (DOT&E, 2021). The U.S. Army Test and Evaluation Command will provide a safety confirmation in the fourth quarter of FY2023. Two flight tests, JFC-2 and JFC-3, are planned to be conducted before fielding the experimental prototype of LRHW by the end of FY2023 (Everstine, 2022). The first flight test, JFC-1, failed in FY2022.

4. The LRHW program is linked to the Navy's Conventional Prompt Strike Program with the common missile, with both Services having different canisters. The Army and the Navy requirements cover the C-HGB and the AUR+C performance. The Army will produce the C-HGB under the Navy Design Authority while the Navy integrates the C-HGB with the two-stage booster stack. The Army will also procure the AUR+C from the Navy.

5. The Navy's CPS is utilizing the MTA rapid prototyping AAF pathway, and the LRHW is not currently on an AAF pathway for Battery 1 but using an OTA. The Army is the only Military Service not operating under an AAF pathway. The Air Force utilizes the MTA rapid prototyping pathways for their hypersonic weapons. Due to the LRHW prototype capability not operating under a required oversight framework, the capability is void of DoD Instruction 5000.80 and the statutory oversight of ASA(ALT) as the AAE. Instead, the RCCTO holds the acquisition oversight of the Army's top modernization programs.

6. PEO Missiles and Space will need to establish a new contract for the LRHW Batteries 1 and 2. Contracts for the C-HGB must also be established under PEO Missiles and Space. Ground Support Equipment is currently utilizing an OT Authority for the TEL and BOC. These

OT Authorities are currently with RCCTO. PEO Missiles & Space does not have a Request for Proposal (RFP) out for the follow-on efforts.

7. Currently there are no basing agreements with ally countries to field LRHW. Due to the range limitation of the system, it may affect the effectiveness if it cannot be fielded near China or Russia such as in the United States Indo-Pacific Command (PACOM) or the United States European Command (EUCOM). There is a considerable probability that the system will only be fielded in the United States and not near China or Russia.

Recommendations

The following are recommendations:

1. The LRHW is the Army's only hypersonic program and a premier program in the Army's signature modernization programs. Due to the significance of this program, an AAF Pathway should be pursued by PEO M&S. It will also provide the AAE with the authority to carry out oversight responsibilities under Title 10 U.S. Code under Title 10 U.S. Code. Based on the analysis, the researcher recommends that the MTA Rapid Fielding Pathway be selected for the LRHW program. This pathway ensures that the timeline from production to fielding will be completed within five years from the beginning of the program. Since the Army plans to field Battery 2 in FY2025 and Battery 3 in FY2027, the more viable AAF Pathway to utilize is the MTA Rapid Fielding.
2. The Navy is leading the C-HGB design effort. Instead of the Army procuring the production activities, it should be explored whether the Navy should be managing the C-HGB contract for all Services. This requires a relook of the MOA and the responsibilities of the C-HGB.
3. Due to the fast pursuit of hypersonic weapons, the Army accepted risk in designing and testing LRHW. The Army also invested billions of dollars in hypersonic technology. This

research recommends analyzing life cycle cost, program delays, rework, modifications, and other Engineering Change Proposals (ECP).

4. The C-HGB MOA among the Services signed in 2019 will expire in 2024. A repository of lessons learned from procuring hypersonic weapons will be beneficial for follow on contracts and other weapons that may be pursued. This also may help lower the costs of hypersonic weapons since the DoD already invested over $15 billion in this technology.

Areas for Future Research

The following are three areas for further research:

1. Research exploring the development of other non-ICBMs that the Army can produce to assist in meeting the goals prescribed in the Army Modernization Strategy.
2. Additional research on hypersonic technology that the Services can utilize collectively, like the C-HGB, should be explored.
3. Research on technology that can convert current ICBMs to non-ICBMs should be investigated.

Summary

This chapter covered the conclusions, recommendations, and areas for future research. The LRHW is part of the Army's strategic long-range precision fires portfolio which is one of the Army's six modernization priorities within the Army's Modernization Strategy. The LRHW complements existing and programmed land-based rockets, cannon artillery, and missile capabilities.

This qualitative study explored the United States Army Acquisition Strategy for hypersonic weapons. The research revealed a viable AAF pathway for the Army to pursue and to meet the goals of fielding the LRHW soonest. Since there is an aggressive program schedule to field this capability as quickly as possible, a recommendation is to examine the costs of the need for hypersonic speed. This accelerated need could generate a tremendous amount of costs of modifications and ECPs in contract costs. Testing Battery 1 will not be complete until after Battery 2 is fielded. Due to minimal margin data on hypersonic weapons within DoD, a repository of lessons learned should be developed among the Services that signed the C-HGB MOA, so information can be shared and leveraged regarding acquisition strategies. Since the Navy manages the AUR+C contract and is the design authority for the C-HGB, a recommendation is to explore whether the Navy should produce the C-HGB.

Billions of dollars will be spent to develop, produce, and field the LRHW. However, there needs to be basing agreements in place to field the system with allied nations. The Army is accepting risk in testing, technology, and costs. However, the price for the speed of delivering the capability expeditiously may not be worth it if the Army cannot secure diplomatic agreements.

Leveraging the Navy's CPS contract may provide a faster way of placing the LRHW on contract. Leveraging these evolving technologies and non-traditional partners may provide an opportunity to close the capability gaps sooner than the projected mid-2030 timeline. The quicker the power capability gaps are closed, the quicker the Army can meet the hypersonic modernization goals prescribed in the Army Modernization Strategy (Army, 2019).

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Appendix A – Glossary of Acronyms

AARW................. Air-Launched Rapid Response Weapon

AAE......................Army Acquisition Executive

AAF......................Adaptive Acquisition Framework

ADM......................Acquisition Decision Memorandum

AFTADS.............Advanced Field Artillery Tactical Data System

ALT......................Acquisition, Logistics, and Technology

AUR.....................All Up Round

AUR+C................All Up Round plus Canister

BOC.....................Battery Operations Center

C-HGB................Common Hypersonic Glide Body

CPS......................Conventional Prompt Strike

DAU.................... Defense Acquisition University

DoD......................Department of Defense

DoDI.....................Department of Defense Instruction

DARPA.................Defense Advanced Research Projects Agency

DF.........................Dongfeng

FAR.......................Federal Acquisition Regulation

FYDP....................Future Years Defense Program

FY.........................Fiscal Year

GAO......................Government Accounting Office

GSE.......................Ground Support Equipment

HEMTT.................Heavy Expanded Mobility Tactical Truck

HCSW...................Hypersonic Conventional Strike Weapon

HGV......................Hypersonic Glide Vehicles

ICBM....................Intercontinental Ballistic Missiles

IOT&E..................Initial Operational Test & Evaluation

JFC........................Joint Flight Campaign

LRHW...................Long Range Hypersonic Weapon

MDA.....................Missile Defense Agency

MDA.....................Milestone Decision Authority

MOA.....................Memorandum of Agreement

MTA......................Middle Tier of Acquisition

NASA....................National Aeronautical and Space Administration

NDAA...................National Defense Authorization Act

NDS.......................National Defense Strategy

OSD.......................Office of the Secretary of Defense

OTA.......................Other Transaction Agreement

OUSD (AT&L).....Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics

OUSD (A&S)........Office of the Under Secretary of Defense for Acquisition and Sustainment

OUSD (R&E)........Office of the Under Secretary of Defense, Research and Engineering

PEO.......................Program Executive Office

PoR........................Program of Record

RCCTO................Rapid Capabilities and Critical Technologies Office

RDTE....................Research, Development, Test, and Evaluation

TEL.......................Transporter Erector Launcher

UCA......................Urgent Capability Acquisition

U.S.........................United States

USD(AT&L).........Under Secretary of Defense, Acquisition, Technology, and Logistics

Appendix B – Author Biography

SENIOR SERVICE COLLEGE FELLOWSHIP
HUNTSVILLE, ALABAMA

Nita M. Clark

Mrs. Clark assumed her duties as the Acquisition Director in the Integrated Fires Mission Command (IFMC) Project Office in PEO Missiles and Space in July 2021. Ms. Clark is responsible for planning, executing, and managing over 41 US contracts and 50 Foreign Military Sales (FMS) contracts with a total value of over $22B. She developed solutions to synchronize System of Systems integration across multiple contracts, reducing program risk and streamlining business processes.

Previously, she served as the Deputy Product Director for Joint Tactical Ground Station (JTAGS) in IFMC Project Office, Program Executive Office Missiles, and Space from October 2016 – July 2021. She led a team of three multi-disciplinary divisions to develop, test, field, and sustain the JTAGS system. She provided direction and guidance in determining staffing and budget programming and execution required to support all areas in the JTAGS mission. She led efforts that achieved Urgent Materiel Release (UMR), fielding JTAGS systems that resulted in the Warfighter getting capabilities sooner than anticipated.

Mrs. Clark served as an Operations Research Analyst Team Lead for several programs of record, where she implemented solutions that properly aligned resources to meet mission goals and improved processes. Additionally, she led efforts that contributed to successful Milestone Decisions and ensured the development, procurement, and sustainment requirements supported the acquisition strategies for the missile weapon systems. Mrs. Clark began her career as an Army Materiel Command Operations Research Analyst Intern at the Command Analysis Directorate in US Army Aviation and Missile Command (AMCOM) in 1995.

Mrs. Clark received a bachelor's degree in Mathematics from the University of South Florida in 1993 and a master's degree in Program Management from the Naval Postgraduate School in 2011. She is DAU Advanced Certified in Program Management and Business – Cost Estimating. She was awarded the Commander's Award for Civilian Service in 2018 for ensuring continued

JTAGS mission success and the Civilian Service Commendation Medal in 2021 for developing and fielding advanced capabilities to the JTAGS Operators. In 2022, she received the Meritorious Civilian Service Award and was inducted into the Honorable Order of Saint Barbara for her contributions to Air Defense Artillery community.