ARMY MODERNIZATION
Air and Missile Defense Efforts Would Benefit from Applying Leading Practices

Report to Congressional Committees

June 2025

GAO-25-107491

United States Government Accountability Office

Accessible Version

GAO Highlights

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Highlights of GAO-25-107491, a report to congressional committees

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Air and Missile Defense Efforts Would Benefit from Applying Leading Practices

Why GAO Did This Study

Since 2018, the Army has focused on modernizing its air and missile defense systems to counter those of near-peer competitors.

A Senate report and the House report accompanying the National Defense Authorization Act for Fiscal Year 2024 include provisions for GAO to review and assess the Army's air and missile defense modernization efforts. GAO's report (1) describes how the Army developed the requirements to modernize these efforts; (2) describes how the Army is acquiring the systems; and (3) assesses the extent to which the Army applied leading practices for product development to these efforts.

GAO reviewed the Army's processes for identifying capability needs and developing requirements for air and missile defense efforts. GAO also reviewed the Army's acquisition approaches, analyzed its President's Budget requests since fiscal year 2021, and assessed the efforts against leading practices for product development that GAO identified in prior work. GAO interviewed officials from Army requirements and program offices and the Department of Defense.

What GAO Recommends

GAO is making six recommendations, including that the Army should implement an iterative product development approach, and assess the benefits and affordability of implementing modern design tools for its air and missile defense efforts. DOD concurred with these recommendations.

What GAO Found

The Army's air and missile defense mission is to protect soldiers, equipment, and facilities from air and missile threats, such as cruise missiles and rockets. These are capabilities that near-peer competitors, such as Russia and China, have invested in. To address these threats, the Army is pursuing multiple efforts to modernize its air and missile defense capabilities.

Army Futures Command is responsible for developing requirements for future Army systems. It identified four capabilities that the Army needs and developed requirements to meet those needs. For example, the Army developed requirements for a short-range air defense system, the Sgt. Stout.

Maneuver-Short Range Air Defense Sgt. Stout

Source: U.S. Army; C. Kauffman. | GAO-25-107491

Since 2021, the Army has identified seven air and missile defense efforts to develop and acquire needed capabilities and increased its requests in the President's Budget to support them. For example, the Army's requests for the efforts increased from $8.8 billion to $11.8 billion from fiscal years 2021 through 2025. The Army also chose acquisition pathways intended to speed development, production, and delivery of capabilities for most efforts.

The Army's development of the seven modernization efforts did not fully apply leading practices for product development. Most efforts use 3D modeling and simulation, in which a static representation of a product is tested with predefined data to understand how it will function in a specific situation. In contrast, leading companies use modern design tools like digital twins (dynamic virtual representations of products) and digital threads (common information sources) early and as part of an iterative development approach. Digital twins can enable design updates in real time. Digital threads connect stakeholders with real-time data across the product life-cycle to help inform decisions.

Fully using these tools can provide efficiencies, such as the ability to anticipate potential design flaws and reduce costs. Assessing the benefits and affordability of using these modern design tools can better position the Army to more quickly change designs than is possible with 3D modeling and simulations alone, speeding the delivery of capability to the soldier.

Contents

Abbreviations

A-CDD	Abbreviated Capabilities Development Document
AFC	Army Futures Command
CDD	Capabilities Development Document
CDID	Capabilities Development and Integration Directorate
CFT	cross-functional team
C-sUAS	Counter-small Unmanned Aircraft Systems
DE	directed energy
DOD	Department of Defense
FAR	Federal Acquisition Regulation
FoCUS	Family of Counter-Unmanned Aircraft Systems
FS-LIDS	Fixed Site Low, slow, small Unmanned Aircraft System Integrated Defeat System
FY	fiscal year
HEL	high energy laser
HPM	high power microwave
IBCS	Integrated Battle Command System
IFPC	Indirect Fire Protection Capability
LTAMDS	Lower Tier Air and Missile Defense Sensor
MCA	major capability acquisition
M-LIDS	Mobile Low, slow, small Unmanned Aircraft System Integrated Defeat System
M-SHORAD	Maneuver-Short Range Air Defense
MTA	middle tier of acquisition
NGSRI	Next Generation Short Range Interceptor
PEO MS	Program Executive Office Missiles and Space
RCCTO	Rapid Capabilities and Critical Technologies Office
RF	rapid fielding
RP	rapid prototyping

June 17, 2025

Congressional Committees

For over 20 years, the Army prioritized counterinsurgency operations in the Middle East, resulting in limited investment in air and missile defense capabilities. Today, the Army's air and missile defense capabilities are challenged by a wide array of current and emerging air and missile threats from near-peer competitors, notably China and Russia, which have invested in a range of air and missile capabilities. This near-peer competitive advantage endangers U.S. military personnel, equipment, and facilities as well as the Army's success on the battlefield. As a result, the Army is pursuing multiple efforts to modernize its air and missile defense capabilities to effectively deter or engage and defeat adversaries on the battlefield.

A Senate report and the House report accompanying the National Defense Authorization Act for Fiscal Year 2024 include provisions for us to review and assess the Army's air and missile defense modernization efforts.[1] Our report (1) describes how the Army developed the requirements to support its modernization of air and missile defense programs and efforts; (2) describes how the Army is acquiring the systems to modernize its air and missile defense programs and efforts; and (3) assesses the extent to which the Army applied leading practices for product development for its air and missile defense modernization programs and efforts.

For the first objective, we reviewed the Army's requirements process and applicable documents, such as directed requirements, abbreviated capabilities development documents, and capabilities development documents. This allowed us to understand how the Army identified the required capabilities it needed and developed the requirements for systems in development. Our review of documents included Army studies that informed the modernization efforts.

For the second objective, we reviewed the Army's acquisition approaches for systems identified in its 2021 Modernization Strategy and for Counter-small Unmanned Aircraft Systems. We focused on the 2021 Modernization Strategy for our review because Army officials said it identified the Army's 35 signature modernization efforts, six of which were for air and missile defense. We also focused on Counter-small Unmanned Aircraft System for our review, which Army officials told us the department added as a modernization effort in 2022. We reviewed acquisition plans, program status updates, and changes to Army requests in the President's Budget and associated schedules since fiscal year 2021.

For the third objective, we assessed whether each air and missile defense effort's development approach was iterative or linear and discussed our applicable leading practices for product development for each effort.[2] To identify the development approach for each air and missile defense modernization effort, we reviewed Army documentation and interviewed Army officials from each effort as well as Army Futures Command and the Army Rapid Capabilities and Critical Technologies Office. To determine the extent to which the Army applied

[1]S. Rep. No. 118-58, at 18 (2023); H. Rep. No. 118-125 at 6 (2023); and National Defense Authorization Act for Fiscal Year 2024, Pub. L. 118-31 (2023).

[2]GAO, *Leading Practices: Iterative Cycles Enable Rapid Delivery of Complex, Innovative Products*, GAO-23-106222 (Washington, D.C.: July 27, 2023); and *Leading Practices: Agency Acquisition Policies Could Better Implement Key Product Development Principles*, GAO-22-104513 (Washington, D.C.: Mar. 10, 2022).

leading practices for product development, we reviewed documents provided by the Army and interviewed officials from the five offices overseeing development of the efforts.

For each of the objectives, in addition to the documentary evidence that we analyzed by objective above, we conducted interviews with Department of Defense (DOD) and Army officials on the Army's air and missile defense requirements process, acquisition efforts, the President's Budget requests, and use of leading practices for product development. We conducted in-person interviews with air and missile defense requirements and program offices at Fort Sill, Oklahoma, and Redstone Arsenal, Alabama, the only two offices that provide such support. Appendix I further describes our objectives, scope, and methodology.

We conducted this performance audit from March 2024 to June 2025 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Army Air and Missile Defense Modernization

From 2001 to 2023, the Army focused its military operations on fighting insurgents on the ground in Iraq and Afghanistan. According to a 2020 Congressional Research Service report, due to the Army's reliance on the Air Force to provide air superiority over the battlefield to protect ground forces from aerial attacks, the Army limited its investments in air and missile defense capabilities. This contributed to a degradation in such capabilities.[3] The 2018 National Defense Strategy shifted military planning and operations from counterinsurgency to large-scale combat operations against near-peer adversaries.[4] As a result, the Army began a campaign to modernize its major weapon systems with new capabilities to support its new warfighting concept of multi-domain operations.[5]

According to the *Army Air and Missile Defense Vision 2028*, air and missile defense is vital to the Army's ability to conduct multi-domain operations.[6] Air and missile defense's mission is to protect the Army's forces and critical assets, among other things, from air and missile threats such as cruise missiles, rockets, fixed and

[3]Congressional Research Service, *U.S. Army Short-Range Air Defense Force Structure and Selected Programs: Background and Issues for Congress*, July 23, 2020.

[4]Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge* (Jan. 19, 2018).

[5]The multi-domain operations concept centers on presenting adversaries with multiple challenges through the combination of capabilities across land, air, sea, cyber, and space simultaneously. The Army plans to have a multi-domain operations-capable force in a single theater by 2028. A domain is an area of activity within the operating environment in which operations are organized and conducted. For example, the Army recognizes five domains: land, air, sea, cyber, and space. See GAO, *Future Warfare: Army Is Preparing for Cyber and Electronic Warfare Threats, but Needs to Fully Assess the Staffing, Equipping, and Training of New Organizations*, GAO-19-570 (Washington, D.C.: Aug 15, 2019).

[6]Department of the Army, U.S. Army Space and Missile Defense Command, *Army Air and Missile Defense 2028* March 2019.

rotary wing aircrafts, and uncrewed aircraft systems or drones. The Army notes that employing a mix of capabilities creates a layered defense system to achieve the best results when responding to threats.

The 2021 Army Modernization Strategy (hereafter the "Modernization Strategy") identified the modernization of air and missile defense as one of its six overall priorities for development and procurement.[7] The Modernization Strategy further identified six signature air and missile defense modernization efforts:[8]

- Integrated Battle Command System (IBCS) is a software-based fire control system that links sensors and weapons to form an integrated fire control network. This system is the primary development effort under the Army's Integrated Air and Missile Defense concept.
- Maneuver-Short Range Air Defense (M-SHORAD) is a family of systems mounted onto Stryker combat vehicles. Increment 1 (Sgt. Stout) includes a suite of weapons, including Stinger missiles and a 30-millimeter automatic cannon.[9] Increment 3 (Next Generation Short Range Interceptor or NGSRI) will replace the Stinger missiles on Sgt. Stout with new missiles that are intended to be mounted and soldier-portable as well as new 30-millimeter ammunition. Future increments will include the use of vehicles other than Stryker.
- Directed Energy (DE) M-SHORAD (Increment 2) incorporates a 50 kilowatt-class laser onto a Stryker combat vehicle in place of the missiles and cannon on Sgt. Stout. DE M-SHORAD is one increment of the M-SHORAD family of systems.
- Indirect Fire Protection Capability (IFPC) Increment 2 is a mobile, ground-based weapon system with missiles that integrates with an existing sensor and IBCS.[10]
- IFPC High Energy Laser (HEL) and High Power Microwave (HPM) use a 300 kilowatt-class laser and a high-power microwave, respectively. While these systems are referred to as IFPC, these variants are a separate development effort from IFPC Increment 2.
- Lower Tier Air and Missile Defense Sensor (LTAMDS) is a multifunction, 360-degree radar that will replace the current Patriot radar.

In addition to the six air and missile defense efforts identified in the Modernization Strategy, Army officials told us that the department subsequently identified Counter-small Unmanned Aircraft Systems (C-sUAS) as an additional air and missile defense capability. According to officials, in 2022, the Army added C-sUAS to the air and missile modernization portfolio. C-sUAS systems offer a variety of threat defeat capabilities, including radars, kinetic weapons, and electronic warfare technology. The Army is pursuing six C-sUAS formal

[7]See U.S. Army, *Army Modernization Strategy: Investing in the Future* (2021). The Army's stated order of importance of the six modernization priorities are: Long Range Precision Fires, Next Generation Combat Vehicles, Future Vertical Lift, Army Network, Air and Missile Defense, and Soldier Lethality. The priorities consist of 35 efforts to develop technologically advanced new equipment and upgrades to existing systems.

[8]When fielding capabilities such as air and missile defense, the Army also develops the doctrine, training, personnel, facilities and other "planning elements" necessary to support the capability. In 2024, we recommended that the Army adjust its planning element process. The Army concurred with our recommendation but as of February 2025, had not yet implemented it. See GAO, *Army Modernization: Actions Needed to Support Fielding New Equipment*, GAO-24-107566 (Washington, D.C.: July 15, 2024).

[9]The Army renamed M-SHORAD Increment 1 to "Sgt. Stout" in June 2024 to honor Vietnam War hero Sgt. Mitchell William Stout, an Army air defense soldier who earned the Congressional Medal of Honor.

[10]According to Army officials, the Indirect Fire Protection Capability is also known as the Integrated Fire Protection Capability.

acquisition programs, as well as numerous other C-sUAS systems that have been deployed or are in prototyping.[11]

The six C-sUAS formal acquisition programs are:

- Fixed Site Low, slow, small Unmanned Aircraft System Integrated Defeat System (FS-LIDS),
- Mobile Low, slow, small Unmanned Aircraft System Integrated Defeat System (M-LIDS),
- Coyote Launchers and Interceptors (Coyote),
- Ku-Band Radio Frequency System Family of Radars,
- Handheld/Dismounted C-sUAS Systems for use by individual soldiers, and
- Family of Counter-UAS Systems.

Army Requirements and Acquisition Processes

The Army must define and validate requirements before acquiring a materiel solution such as a radar or missile. Requirements describe the capability to be achieved using operational performance attributes—testable and measurable characteristics—to design a system intended to address identified capability needs.

Depending on the acquisition strategy, the Army may choose to create a more flexible, less formalized set of desired capabilities and use prototypes and testing to refine the capabilities into formal requirements. These desired capabilities can be documented in an Abbreviated Capabilities Development Document (A-CDD) at a high-level. The A-CDD is reviewed and approved by the Army Requirements Oversight Council, which includes the Army's civilian and military leadership. The Army uses A-CDDs to facilitate rapid prototyping and to help inform and develop requirements before finalizing them. The Army documents specific key performance parameters and key system attributes that a proposed materiel solution must meet in a Capabilities Development Document.[12] The CDD is reviewed and validated by DOD's chief military officers through the Joint Requirements Oversight Council.[13] CDDs are required for acquisition programs on the major capability acquisition pathway.[14]

In January 2020, DOD established the Adaptive Acquisition Framework.[15] The framework emphasizes several principles that include simplifying acquisition policy, tailoring acquisition approaches, and conducting data-driven analysis. The Adaptive Acquisition Framework includes six acquisition pathways that have distinct

[11]A formal acquisition program is a designated and structured effort managed in accordance with DOD acquisition policies, procedures, and funding requirements established by regulations and statute.

[12]Key performance parameters are measurable parameters that define the critical performance of a proposed system. Key system attributes are measurable attributes that define important performance characteristics of the proposed system.

[13]Chairman of the Joint Chiefs of Staff Instruction, *Charter of the Joint Requirements Oversight Council (JROC) and Implementation of the Joint Capabilities Integration and Development System (JCIDS)* CJCSI 5123.01I (Washington, D.C.: Oct. 30, 2021).

[14] Department of Defense, *Major Capability Acquisition,* DOD Instruction 5000.85, (Aug. 6, 2020).

[15]Department of Defense, *The Defense Acquisition System,* DOD Directive 5000.01 (July 28, 2022); *and Operation of the Adaptive Acquisition Framework*, DOD Instruction 5000.02 (Jan. 23, 2020).

processes for pathway decision events, cost and schedule goals, and documentation. The four pathways that the Army used for its air and missile defense modernization efforts are as follows:[16]

- Urgent Capability Acquisition pathway is intended to field capabilities to fulfill urgent existing and/or emerging operational needs or quick reactions in less than 2 years.[17]
- Middle Tier of Acquisition (MTA) includes two expedited pathways. The first path, rapid prototyping, is intended to quickly develop and demonstrate a capability in an operational environment within 5 years. Rapid prototyping also results in materiel that a military department can field to the soldier as an interim capability solution. The second path, rapid fielding, is intended to begin production of a new or upgraded capability within 6 months, and complete fielding of that capability within 5 years.[18] Acquisitions using the MTA pathway are generally not subject to the same DOD acquisition and requirements processes as those on the major capability acquisition pathway.
- Major Capability Acquisition (MCA) pathway leads complex acquisitions through phases, such as technology development, system development, and production. DOD separates these phases by major reviews known as milestone decisions.[19]
- Software Acquisition pathway is intended to facilitate rapid and iterative delivery of software capability, including software-intensive systems, to users.[20]

Figure 1 shows selected Adaptive Acquisition Framework pathways the Army has or is using for air and missile defense efforts.

[16]The other two acquisition pathways not included in this report are Defense Business Systems and Defense Acquisition of Services.

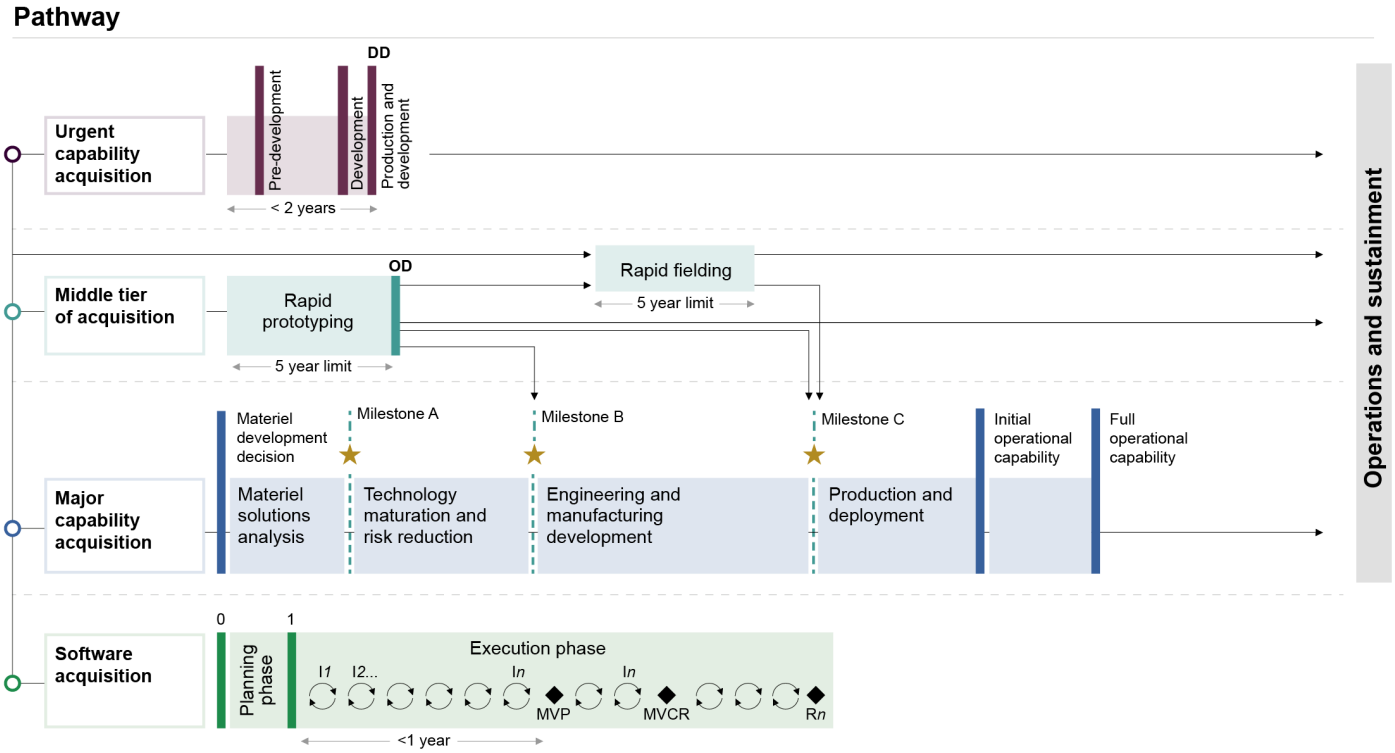
[17]Department of Defense, *Urgent Capability Acquisition*, DOD Instruction 5000.81 (Dec. 31, 2019).

[18]For programs using the MTA pathway, the start date (and thus the date from which the 5-year time frame is measured) for programs designated on or after December 30, 2019, is generally the date that an acquisition decision memorandum was signed initiating an MTA rapid prototyping or rapid fielding program. MTA programs designated before December 30, 2019, and certain programs designated after this date, generally maintain their MTA program start date as the date funding was first obligated. See Department of Defense, *Operation of the Middle Tier of Acquisition*, DOD Instruction 5000.80 (Dec. 30, 2019).

[19]Major defense acquisition programs generally include those programs that are either (1) designated by the Secretary of Defense as a major defense acquisition program; or (2) estimated to require an eventual total expenditure for research, development, test, and evaluation, including all planned increments or spirals, of more than $525 million in fiscal year 2020 constant dollars or, for procurement, including all planned increments or spirals, of more than $3.065 billion in fiscal year 2020 constant dollars. See 10 U.S.C. § 4201(a). DOD Instruction 5000.85 (reflecting statutory major defense acquisition program cost thresholds in fiscal year 2020 constant dollars). Certain programs that meet these thresholds, including programs using the MTA pathway, are not considered major defense acquisition programs. See 10 U.S.C. § 4201(b).

[20]Department of Defense, *Operation of the Software Acquisition Pathway*, DOD Instruction 5000.87 (Oct. 2, 2020).

Figure 1: Selected Department of Defense Adaptive Acquisition Framework Pathways



Source: GAO analysis of Department of Defense data. I GAO-25-107491

The military departments can also transition efforts from one pathway to another. For example, DOD's MTA policy states that military departments will develop a process for transitioning successful prototypes from the rapid prototyping pathway to new or existing programs for production, fielding, and operations and sustainment under the rapid fielding pathway or another acquisition pathway. Military departments can also cancel an MTA effort that has not progressed as expected.

Multiple Army organizations have responsibility for activities associated with the acquisition of air and missile defense systems:

- **The Office of the Assistant Secretary of the Army for Acquisitions, Logistics, and Technology** is the support organization for materiel acquisition and is responsible for the delivery of modernization efforts to the soldier. This organization is the civilian authority responsible for overseeing all Army acquisition functions and can serve as the milestone decision authority. This office oversees 12 program executive offices that acquire different types of systems or equipment across the Army, including air and missile defense systems.
  - **Program Executive Office Missiles and Space** is responsible for overseeing the air and missile defense portfolio of acquisition programs, among others, and delivering a suite of capabilities to soldiers.

- **Army Futures Command (AFC)** was established in 2018 to develop requirements and technologies for future Army systems. AFC determines the capabilities required for these acquisitions through organizations such as:
  - **Air and Missile Defense Cross-Functional Team (CFT)** has lead responsibility for developing requirements to address Army air and missile defense capability needs. The Army established the air and missile defense CFT in 2017 to better support the requirements process for air and missile defense. The air and missile defense CFT includes stakeholders from the requirements, acquisitions, and user communities, among others, to coordinate requirements development.
  - **Fires Capabilities Development Integration Directorate (Fires CDID)** also has responsibility for developing requirements to address Army air and missile defense capability needs and works closely with the air and missile defense CFT. Fires CDID developed related concepts, requirements and experimentation. It coordinates operational units input during requirements development and prototyping. In addition, the Fires CDID includes an Army Capability Manager who represents the interests of the operational units and collaborates with them to identify issues and solutions.
  - **The Research and Analysis Center** is responsible for conducting studies and testing for the Army's air and missile defense modernization efforts.
- **The Army Rapid Capabilities and Critical Technologies Office (RCCTO)** is responsible for maturing technologies to develop prototypes, which help to refine requirements before efforts transition to acquisition program offices. For example, this office is responsible for development of directed energy efforts. RCCTO reports directly to a board of directors led by the Secretary of the Army and includes the Chief of Staff of the Army, Under Secretary of the Army, Vice Chief of Staff of the Army, Army Acquisition Executive, and the Commanding General of AFC. It also uses separate prototyping and contracting authorities to facilitate its efforts outside of traditional acquisition pathways.

Leading Practices for Product Development

We have identified leading practices for iterative product development that are based on practices used by leading companies to develop complex, innovative products.[21] Leading companies use iterative processes to design, validate, and deliver complex products with speed. This iterative process involves continuous cycles of design modeling and simulation, validation, and production through which companies rapidly develop and deliver products that provide essential capabilities that users need. These iterative cycles include activities such as:

- **Attain and maintain a sound business case.** Leading companies increase knowledge about a product's capabilities and design characteristics through each iterative cycle. In doing so, leading companies conduct market research and obtain and use customer feedback to establish and then continually maintain a sound business case throughout development. When initiating development of a product, leading companies do not start with a business case that includes a detailed specification of requirements, which typically inform traditional linear development such as that generally pursued under DOD's major acquisition contracts. This linear approach has fixed operational requirements needed to deliver a capability to meet predetermined performance criteria. Instead, leading companies begin product development with a high-level need statement or idea to provide flexibility to demonstrate what capabilities are possible within the

[21]GAO-23-106222 and GAO-22-104513.

effort's cost and schedule constraints. Throughout development, this high-level need is progressively refined into distinct requirements based on the demonstrated performance of product prototypes.

- **Identify a minimum viable product.** Leading companies identify a minimum viable product—a product with the minimum capabilities needed for customers to recognize value and that can be followed by successive updates. Companies arrive at a producible, minimum viable product once product developers, manufacturers, and users have agreed that the product meets essential needs and can be produced within the cost and schedule allotted. Such determination concludes the end of the validation cycle. This means it is rooted in actual demonstration and knowledge rather than forecasted through requirements imposed at the start of product development. Leading companies also enable the initial business case to evolve over the course of product development as well as connect the business case to research and development. This means that research and development for a specific product does not end with the product—it continues so that future iterations of the product will have new, innovative, and mature technologies available.
- **Obtain stakeholder and end user feedback.** Leading companies seek and obtain continuous stakeholder and end user feedback—feedback from the actual operators of the product—throughout the iterative cycles. These companies capture this feedback to ensure the product under development is relevant and responsive to evolving user needs. Inputs from users directly inform and underpin achievement of a producible minimum viable product as well as successive improvements to that product in future iterations.
- **Prioritize schedule by off-ramping capabilities when necessary.** To achieve speed to market, leading companies prioritize developing a minimum viable product by removing capabilities that pose a risk to delivering the product on schedule. The off-ramped capabilities can be deferred to a later release or terminated.
- **Use of modern design tools.** Leading companies use modern design tools, including 3D modeling and simulation, digital twins—virtual representations of physical products—and digital threads. Digital twins incorporate dynamic data of a physical object or a system—meaning the model changes and updates in real time as new information becomes available. Digital twins differ from 3D models, which are static visualizations that are updated manually, and are essentially paper design drawings in digital form. Digital threads are a common source of information that connect stakeholders with real time data across the product life cycle. Digital threads are the starting point for subsequent iterations of the product. Leading companies use digital twins and digital threads early in product development to reduce risks related to manufacturing and production that can delay product delivery.

Army Futures Command Identified Capability Needs for Air and Missile Defense and Developed Capabilities to Address Them

Army Futures Command Prioritized Four Capability Needs for Air and Missile Defense

The Army identified and prioritized four capability needs through a capability determination process. The Army identified these needs by comparing its current air and missile defense capabilities, how the Army intended to use these capabilities to deter or engage in conflict, and the threats posed by the capabilities of near-peer competitors and other adversaries.

For air and missile defense, this process identified four capability needs for which the Army decided to develop materiel solutions.[22] These include:

- Protection for maneuver formations against aerial threats such as uncrewed aircraft systems, fixed and rotary wing aircrafts, and rockets, mortars, and artillery.
- Protection for critical fixed and semi-fixed assets (e.g., air bases and mission command posts) against aerial threats such as cruise missiles, uncrewed aircraft systems, rockets, artillery, and mortars and fixed and rotary wing aircrafts.
- A common mission command-control system that connects sensors and shooters to enable a layered defense against complex, integrated aerial attacks.
- A radar with improved sensor capability integrated into a common mission command system to provide greater coverage and range than current radar systems.

Generally, there are several ways the Army can identify capability needs. These include, but are not limited to, the national defense strategy and new Army warfighting concepts such as Multi-Domain Operations. In addition, the Army conducted studies and used intelligence threat assessments. For example:

- According to Army documentation, a 2017-2018 capability needs analysis revalidated the areas identified in a July 2005 intelligence threat study. The 2005 study noted that IBCS would encounter a wide range of threats. including ballistic missiles, cruise missiles, uncrewed aircraft systems, fixed and rotary wing aircrafts, and rockets, artillery, and mortars. The 2005 study also noted that the threats may employ coordinated complex integrated attacks, consisting of multiple weapon types in large numbers to overwhelm ground-based defenses.
- Army documentation noted that a 2016 capability needs analysis identified and validated the need for short range air defense capabilities in maneuver formations. This analysis stated that maneuver formations require these capabilities to counter aerial threats, such as uncrewed aircraft systems, and rockets, artillery, and mortars.

Army air and missile defense capability needs have also been identified by senior Army leaders. These leaders can direct the development of a materiel or non-materiel solution—called a directed requirement—to address an urgent capability need. For example, short-range air defense capability needs were identified by Army leadership in Europe and directed energy capability needs were based on requirements from the RCCTO Board of Directors.

The AFC air and missile defense CFT, with assistance from the Fires CDID, is responsible for the capability needs analysis process associated with all Army air and missile defense modernization efforts. According to Army officials, this process is continuous, and AFC often revisits capability needs identified previously to revalidate or refine them based on combat experiences. The Fires CDID was the lead for the analysis, development, writing, and experimentation that identified the ways to address the needs associated with air and missile defense. Fires CDID officials identified that they used their Battle Lab to analyze and determine the most appropriate models and simulations to use for each concept. The Battle Lab also conducted table-top exercises and wargames that committed existing and proposed capabilities against an adversarial force to determine the capabilities needed to fight and win on current and future battlefields. Although the air and missile defense CFT and the Fires CDID are the primary developers of desired capabilities and requirements

[22]A capability need may also be addressed by non-materiel solutions, such as changes to doctrine, organization, or training.

for the modernization efforts, Army officials stated that they consult others as well. This includes input from stakeholders like the commanders of operational units in-theater and an Army Capability Manager responsible for presenting the soldier's perspective.

Army Developed Requirements to Address the Identified Capability Needs

To address the identified capability needs, the Army developed desired characteristics or more specific requirements documents for the seven air and missile defense systems noted below.

IBCS: To address the identified need for a common mission command-control system, the Army developed the requirements for IBCS. In 2010, the Fires CDID described the requirements for IBCS in a CDD and validated the key performance parameters and resource constraints. In 2020, air and missile defense CFT and Fires CDID officials updated the requirements as a part of the 2021 program restructuring and validated the key performance parameters. This updated CDD was used to support a production decision in 2021.

M-SHORAD: According to Army officials, the M-SHORAD family of systems is comprised of five increments, each with its own specific desired capabilities or requirements. All five increments of the M-SHORAD are intended to protect maneuver formations against aerial threats.

- The Army initiated the Sgt. Stout in response to an approved directed requirement from February 2018 to address the urgent need for an air defense capability to protect maneuver formations. The air and missile defense CFT developed the requirements in a November 2022 CDD.
- The Army derived the A-CDD for NGSRI from a previous requirements document developed for Sgt. Stout. The A-CDD for NGSRI included the desired capabilities for a new missile to replace the Stinger missile. The Army desires the new missile to have improved target acquisition, range, and lethality to counter evolving aerial threats. The A-CDD also included a desired capability for the new missile to not be heavier than the current Stinger missile so it can be used by both a vehicle mounted launcher and a soldier. The A-CDD for NGSRI identified that the new missile should be able to defend the maneuver force against cruise missiles, fixed and rotary wing aircrafts, and uncrewed aircraft systems threats. The A-CDD also provided for a new 30-millimeter ammunition for the cannon used on the Sgt. Stout platform. According to Army officials, this A-CDD will eventually lead to formalized requirements in a CDD, projected for completion in early fiscal year 2028. Officials said they are currently working with the Army Capability Manager as the user representative to inform further development of the A-CDD.
- According to Army officials, requirements for M-SHORAD Increments 4 (a light variant) and 5 (a heavy variant) have yet to be determined. In May 2024, however, the Army issued a request for information for Increment 4 to inform development of future requirements for air defense capability to support dismounted maneuvers.

DE M-SHORAD: Officials stated that, in 2018, the Army identified DE M-SHORAD as one of the increments under the M-SHORAD family of systems. Subsequently, in May 2019, Army officials directed RCCTO to initiate the effort with a 50-kilowatt class laser system under its prototyping authority as a complementary capability to other systems within the M-SHORAD family.[23] RCCTO is using the effort's A-CDD, dated January 2023, for the

[23]The Army's supplement to the Federal Acquisition Regulation (FAR) gives specific authority to the head of the contracting activity for RCCTO to award and administer agreements for rapid prototyping of strategically important capabilities. Army Federal Acquisition Regulation Supplement 5101.601-90(b)(6).

effort to pursue directed energy capabilities to address the need to protect maneuvering forces. This A-CDD supports RCCTO's prototyping to develop enduring directed energy capabilities.

IFPC Increment 2: The Army prepared the IFPC Increment 2 CDD in November 2016 to address the need for protection of critical fixed and semi-fixed assets—such as airfields and supply depots—against aerial threats. According to Army officials, an updated CDD was approved in March 2025. These officials noted that the updated requirements document reflects insights from ongoing conflicts. IFPC Increment 2 is intended to provide 360-degree protection with the ability to engage simultaneous threats arriving from different altitudes and directions, such as cruise missiles and uncrewed aircraft systems.

IFPC HEL and HPM: RCCTO is developing two directed energy variants of IFPC. The Army intends for IFPC HEL and HPM to address the need for protection of critical fixed and semi-fixed assets against aerial threats. The Army developed A-CDDs for directed energy efforts. According to RCCTO officials, IFPC HPM's A-CDD was approved in April 2025; and IFPC HEL's A-CDD is still in draft. Like IFPC Increment 2, IFPC-HEL is designed to detect, track, identify, engage, and defeat airborne threats to defend fixed and semi-fixed sites in a range of combat environments.

IFPC-HPM uses microwave energy to damage or disrupt targets. The Army is pursing directed energy weapons, such as IFPC HPM, to address near peer threats in support of the Army's Modernization Strategy. The RCCTO Board of Directors directed RCCTO to pursue this capability. RCCTO, through prototyping efforts, informed the desired characteristics in a draft A-CDD. IFPC-HPM is designed to provide 360-degree protection for fixed and semi-fixed sites or assets from small, uncrewed aircraft systems individually and in swarms approaching from different directions and altitudes.

LTAMDS: A 2016 Army-led analysis of alternatives identified the need to develop a new radar system and recommended the development of sensor capabilities in air and missile defense units. The Army developed a draft CDD using the long-standing approved operational requirements for a new sensor that could link to IBCS. In February 2024, the program office submitted an updated CDD in support of the decision to transition to the MCA pathway at production, which is currently planned for the second quarter of fiscal year 2025. LTAMDS supports the air and missile defense mission against threats such as tactical ballistic missiles, cruise missiles, anti-radiation missiles, uncrewed aircraft systems, and rotary and fixed-wing aircrafts.

C-sUAS: The Army is pursuing six C-sUAS formal acquisition programs, as well as numerous other C-sUAS systems, to address the need for protection of maneuver formations and critical fixed and semi-fixed assets against aerial threats. The Army developed required capabilities for five of the six C-sUAS programs based on a joint urgent operational need in 2016. Officials stated that the Army identified the need for these capabilities, in part, due to experiences by Iraqi forces with combatting uncrewed aircrafts in Iraq. In February 2022, the Army approved a CDD for the five C-sUAS formal acquisition programs. In 2023, AFC approved the directed requirement for the sixth.

While the Army's desired capabilities and requirements for air and missile defense modernization were generally established prior to the start of the current conflicts in the Ukraine and the Middle East, according to Fires CDID officials, analysis of these conflicts resulted in a revalidation of those capabilities and requirements. For example, officials stated that these conflicts reemphasized the need for mobility and survivability on the modern battlefield as well as the need to defeat evolving threats such as swarms of drones. Officials also stated that the Army revisited its tactics, techniques, and procedures for operations with air and missile defense platforms based on insights from current conflicts as a part of revalidating the requirements.

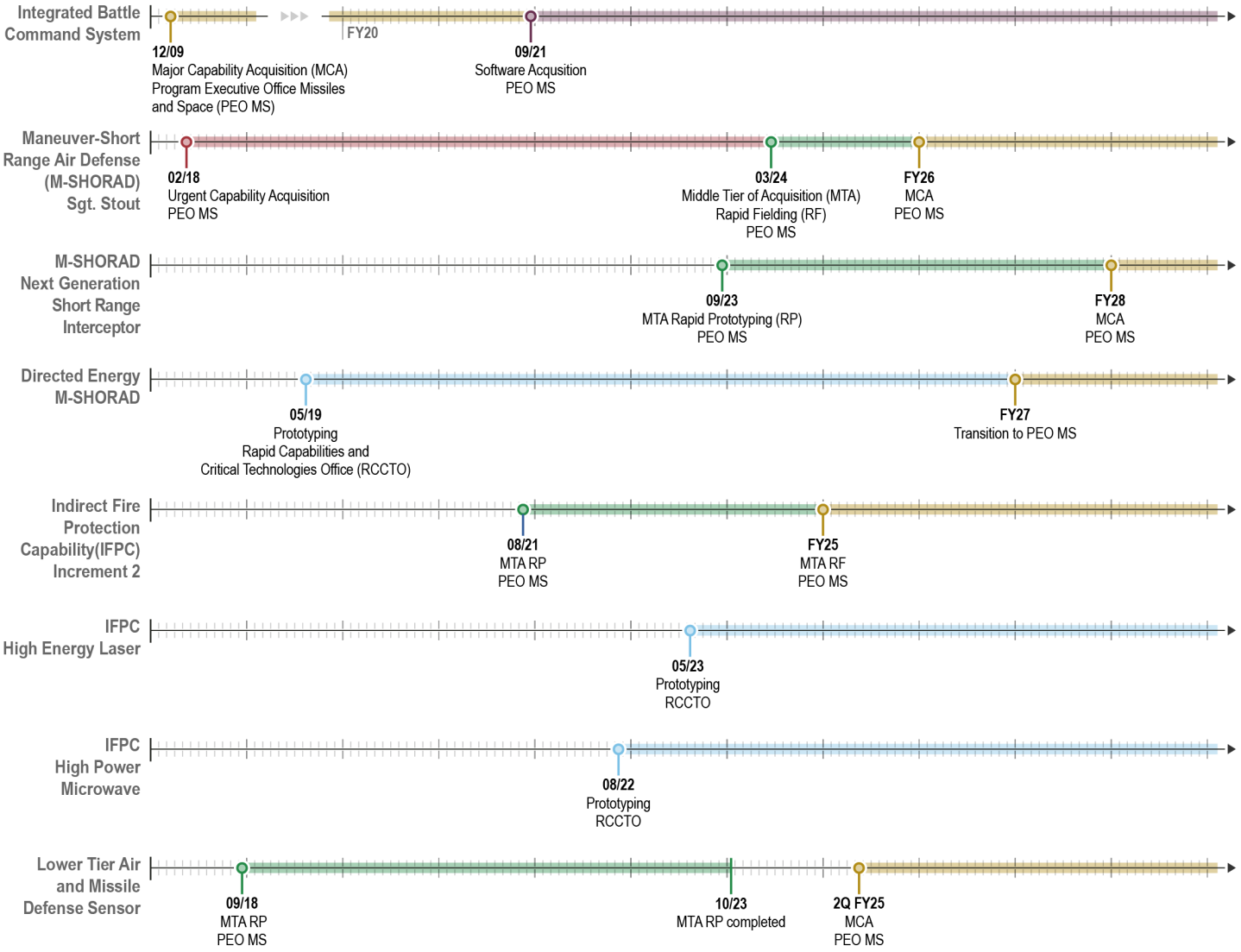
Army Prioritized Rapid Development and Fielding of Air and Missile Defense Capabilities, Increasing Its Budget Requests, but Has Had Limited Success

The Army chose accelerated acquisition pathways and flexible agreement types to develop and field systems to address required capabilities—and submitted increased funding requests through the budget process to support them—but has not yet fielded most of the air and missile defense modernization efforts. For system development, the Army generally used pathways intended to accelerate development, production, and delivery of the required capabilities. The Army also used other transaction agreements in an attempt to speed development and offer flexibilities to vendors. Since the release of the Modernization Strategy in 2021, the Army increased its funding requests by approximately $3 billion to support the development and procurement of these systems. Of the eight systems we reviewed, five identified performance or integration issues that delayed their transition into production. These systems included DE M-SHORAD, all variants of IFPC, and LTAMDS.

For system development, the Army generally used acquisition pathways—such as MTA, Urgent Capability Acquisition, and the Software Acquisition pathway—that are intended to accelerate development, production, and delivery of materiel capabilities. However, the Army subsequently plans to use the more traditional MCA pathway for production of most air and missile defense systems. Further, although the Army prioritized accelerated development, multiple modernization efforts have experienced setbacks during development that have extended their timelines.

See figure 2 for acquisition pathways and oversight offices for air and missile defense modernization efforts.

Figure 2: Acquisition Pathways and Oversight Offices for Selected Air and Missile Defense Modernization Efforts



Q = Quarter; FY = Fiscal Year

Source: GAO analysis of Department of the Army documentation. | GAO-25-107491

The Army used other transaction agreements during development. Army officials said that these agreements could provide increased speed and flexibility as well as increased opportunities to work with nontraditional vendors.[24] Following development, the Army plans to transition air and missile defense efforts to Federal Acquisition Regulation (FAR)-based contracts for production. According to officials, FAR-based production

[24]Officials previously told us that the time needed to award a prototype other transaction agreement can vary significantly. Our analysis found that award time ranged from 45 to 370 days. See GAO, *Defense Acquisitions: DOD's Use of Other Transactions for Prototype Projects Has Increased*, GAO-20-84 (Washington, D.C.: Nov. 22, 2019).

contracts help to ensure vendor compliance with federal rules and regulations and include standardized language that protects the government's investments.[25]

To support the development and procurement of the required capabilities the Army has repeatedly increased its funding requests for the priority systems it identified in the 2021 Modernization Strategy and C-sUAS. In the fiscal year 2021 President's Budget, the Army requested approximately $8.8 billion for the period from fiscal years 2021 through 2025 for these systems. By fiscal year 2025, the Army had requested approximately $11.8 billion for the same systems. The $3 billion increase was due to the inclusion of systems that did not appear in the fiscal year 2021 budget request, such as IFPC HEL and HPM, as well as changes in funding needed to support further testing or shifting procurement profiles.

Specifics on the acquisition pathways, agreement types, and funding changes for each of the required capabilities are as follows:

Integrated Battle Command System (IBCS)

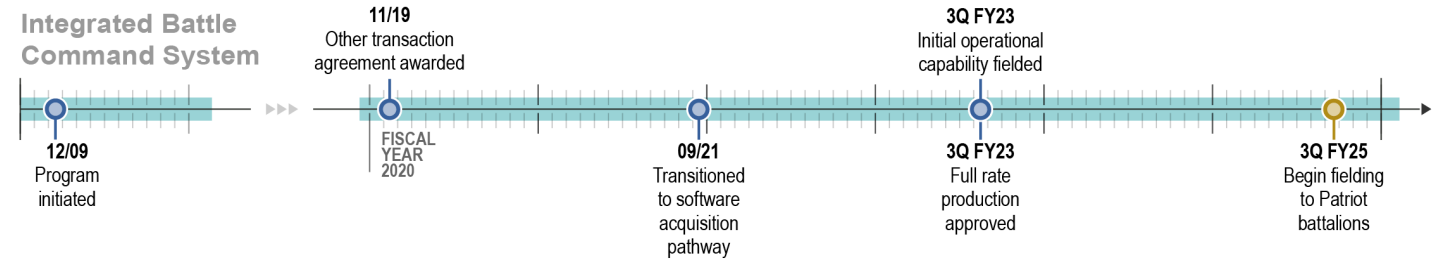
IBCS is the central system of, and the materiel solution to, the Army's Integrated Air and Missile Defense concept, which envisions an integrated system-of-systems layered approach to air and missile defense.

Source: U.S. Army. | GAO-25-107491

I**BCS,** which began development more than 15 years ago**,** has experienced numerous challenges in early development, including poor software performance and evolving requirements. The Army restructured the program in September 2021 to enter the Software Acquisition Pathway. Figure 3 shows a timeline of selected events for the program.

[25]We have an ongoing review assessing the extent to which selected efforts using other transaction agreements for prototyping have transitioned or plan to transition to follow-on production under other transaction agreements or FAR-based contracts. We plan to issue our report on these selected efforts in the summer of 2025.

Figure 3: Integrated Battle Command System Selected Events Timeline



Q = Quarter; FY = Fiscal Year

Source: GAO analysis of Department of the Army documentation. | GAO-25-107491

The Software Acquisition pathway uses an Agile development approach, which, according to officials, can result in faster development, upgrades, and improvements for IBCS through quarterly software updates. According to officials, the Army awarded one other transaction agreement for the effort and plans to award another to further develop the software. It awarded the initial other transaction agreement for prototyping, facilitated through a consortium, to Northrup Grumman in November 2019.[26] Program officials stated that they are leveraging other transaction agreements because they provide flexibility to off-ramp capabilities quickly.

Since transitioning to the Software Acquisition pathway, the IBCS program has made progress in its development. The Army fielded an initial operational capability, which included IBCS integrated with the Patriot weapon system and the Sentinel A3 radar, to an Air Defense Artillery battalion in the third quarter of fiscal year 2023. According to Army officials, the battalion is currently limited to operating as a test unit at White Sands Missile Range until further testing is completed. IBCS is currently in low-rate initial production and was approved for full-rate production in fiscal year 2023. These officials told us that the program is on track to begin fielding systems to active Patriot battalions in fiscal year 2025, and the program intends to field it to two Patriot battalions per year until 16 battalions are fielded.

IBCS needs to integrate with other air and missile defense systems to provide capability. The Army developed a “1-to-N” priority list of systems to determine the order in which to integrate these systems with IBCS. According to Army officials, other systems must coordinate their development and testing with IBCS, which may affect the timeline for integrating other systems with the program in the future.

Although IBCS is primarily a software development program, it also includes three hardware components: the Engagement Operations Center that functions as the primary fire control center for engaging targets; the Integrated Collaborative Environment that provides a collaborative environment for battlefield mission command; and the Integrated Fire Control Relay, which is an antenna that connects different sensors and

[26]DOD can award other transaction agreements directly to individual organizations or through a consortium, which is an association of organizations established to provide DOD with a pool of stakeholders to innovate in specific technology areas. A consortium can be composed of traditional defense contractors, nontraditional companies, nonprofit organizations, and academic institutions. The Army awarded other transaction agreements through a consortium for the IBCS and M-SHORAD (Sgt. Stout, DE M-SHORAD, and NGSRI) efforts.

weapon systems to the IBCS network. According to Army officials, the hardware components are on the MCA pathway and use FAR-based contracts.

Since 2021, the Army has increased its budget requests for IBCS. In 2021, the Army anticipated requesting a total of $2.3 billion for the program's development and procurement from fiscal years 2021 through 2025. The Army requested $460.5 million for development and $1.8 billion for procurement. By the time it submitted the fiscal year 2025 budget, the Army had requested $3.2 billion for IBCS, including $1.4 billion for development and $1.8 billion for procurement. The increase in requests for development funding reflected the need for more testing than the Army originally anticipated.

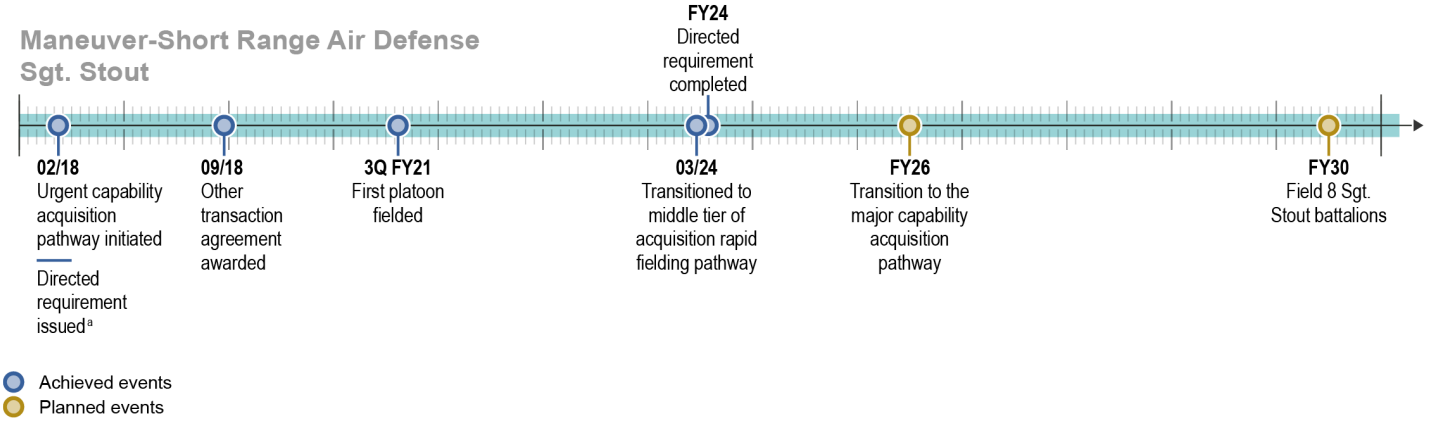
Maneuver-Short Range Air Defense (M-SHORAD) Increment 1: Sgt. Stout

Sgt. Stout includes a suite of weapons, including Stinger missiles and a 30-millimeter cannon, integrated onto a Stryker Combat Vehicle.

Source: U.S. Army; C. Kaufmann. | GAO-25-107491

M-SHORAD Sgt. Stout and NGSRI are on the MTA pathway. The Army initiated Sgt. Stout in response to a requirement directed by the Army's Vice Chief of Staff in 2018 to address the urgent need for air defense capability to protect maneuver formations. By 2024, the effort had transitioned to the MTA rapid fielding pathway. Figure 4 below shows a timeline of selected events for Sgt. Stout.

Figure 4: Maneuver-Short Range Air Defense Sgt. Stout Selected Events Timeline



Q = Quarter; FY = Fiscal Year

Source: GAO analysis of Department of the Army documentation. | GAO-25-107491

[a]The Army can prepare directed requirements in cases where a specific but limited necessary urgent need exists. To arrive at a directed requirement, Army leaders identify capability needs and direct the development of a materiel or non-materiel solution to address the needs.

The Army awarded other transaction agreements for prototyping to General Dynamics Land Systems, Inc. and Raytheon Company in 2018, and DRS Sustainment Systems, Inc. in 2019. Officials told us that they chose to use this agreement for prototyping because it allowed for more rapid execution of the effort.

In September 2021, after fielding the first platoon of Sgt Stout, the Army decided to replace the system's Hellfire missile launcher with a second Stinger missile launcher after it identified performance and safety concerns during an operational assessment. According to officials, the Army will retrofit the systems it has already procured to a dual Stinger missile launcher configuration beginning in fiscal year 2026.

The Army approved Sgt. Stout to transition to the MTA rapid fielding pathway in March 2024. The Army completed procurement of the final 10 systems to fulfill the directed requirement and fielded a battalion in fiscal year 2024 and plans to complete fielding to another battalion in the first quarter of fiscal year 2026. The Army is using a FAR-based contract for production.

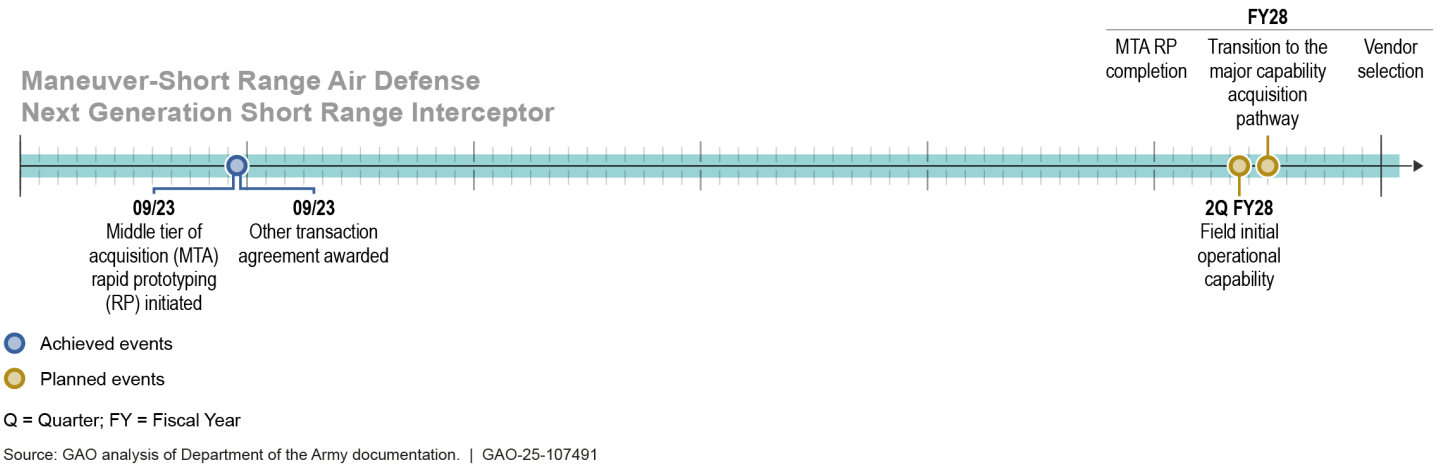
Maneuver-Short Range Air Defense (M-SHORAD) Increment 3: Next Generation Short Range Interceptor (NGSRI)

NGSRI intends to replace Sgt. Stout's Stinger missile with a more advanced short-range interceptor that increases range and lethality.

Source: U.S. Army. | GAO-25-107491

The Army is pursuing an additional M-SHORAD increment, NGSRI, that adds capability to Sgt. Stout. In 2023, the Army initiated NGSRI using the MTA for rapid prototyping. See figure 5 for a timeline of selected events for NGSRI.

Figure 5: Maneuver-Short Range Air Defense Next Generation Short Range Interceptor Selected Events Timeline



Q = Quarter; FY = Fiscal Year

Source: GAO analysis of Department of the Army documentation. | GAO-25-107491

As part of the MTA, the Army selected two vendors, Raytheon Company and Lockheed Martin, to develop prototypes and awarded each an other transaction agreement in 2023.[27] Officials told us they plan to select one vendor in fiscal year 2028. NGSRI intends to field two platoons with 48 missiles each as well as transition to the MCA pathway at production start in fiscal year 2028.

Maneuver-Short Range Air Defense Increment 2: Directed Energy (DE M-SHORAD)

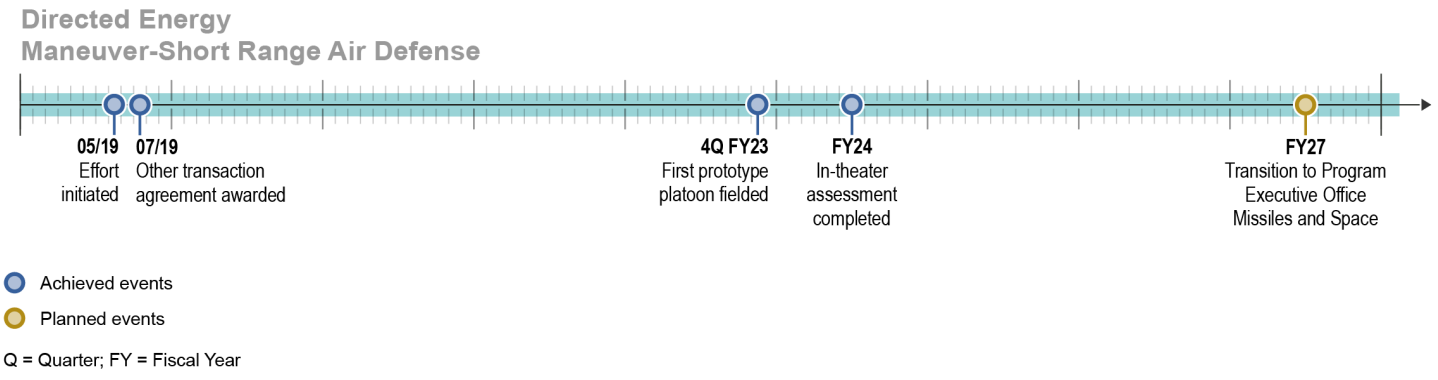
DE M-SHORAD is a 50 kilowatt-class laser integrated onto a Stryker vehicle. It is designed to defend maneuvering forces against a variety of threats, such as uncrewed aircraft systems, and rockets, artillery, and mortars.

Source: U.S. Army. | GAO-25-107491

The Army plans to develop two future M-SHORAD increments. Increment 4 will replace the Stryker platform with a lighter vehicle for light and joint forcible entry maneuvering forces. Increment 5 will replace the Stryker platform with a heavier vehicle with increased armor to defend armored forces. According to officials, there is not yet funding or approved requirements for either increment.

DE M-SHORAD, under development with RCCTO, is one of the increments under the M-SHORAD family of systems. Figure 6 shows a timeline of selected events for the effort.

Figure 6: Directed Energy Maneuver-Short Range Air Defense Selected Events Timeline



Q = Quarter; FY = Fiscal Year

Source: GAO analysis of Department of the Army documentation. | GAO-25-107491

In 2019, the Army awarded an other transaction agreement for prototyping to Kord Technologies, Inc. Officials told us that they chose to use this agreement because it allows for quicker acquisition and development and is more flexible than FAR-based contracts. The effort delivered the first four prototypes to an Air Defense Artillery platoon in the fourth quarter of fiscal year 2023. According to Army officials, RCCTO conducted an in-theater assessment with the platoon using the prototypes in fiscal year 2024. RCCTO delayed the effort's transition to

[27]A separate Army effort will develop a new 30-millimeter ammunition for M-SHORAD Increment 3. We did not assess the Army effort for the new 30-millimeter ammunition.

a program office by approximately 2 years after results from the prototype system demonstration and experimentation events determined that the system was not mature enough to support the transition. Consequently, the effort will not begin production in fiscal year 2025 as previously planned, production is now expected to begin in fiscal year 2027. Officials stated that the Army is also considering a new configuration for the system that does not include the Stryker platform on which it is currently mounted. At transition to a program office, the Army will refer to the effort as Enduring High Energy Laser. Officials added that the effort has continued development of two alternative design prototypes to pursue improvements of critical technologies.

The Army's funding requests for M-SHORAD Sgt. Stout, DE M-SHORAD, and NGSRI generally decreased from fiscal years 2021 through 2025. In the fiscal year 2021 President's Budget, the Army requested a total of $3.2 billion for the development and procurement of M-SHORAD for fiscal years 2021 through 2025.[28]

- In the 2021 budget request, the Army requested $2.2 billion for Sgt. Stout, with $49.8 million for development and $2.1 billion for procurement. By the 2025 budget request, the Army had increased its requests for development to $61.6 million but decreased its procurement requests to $1.5 billion. The decrease in procurement funding is due to the use of Ukraine supplemental appropriations for procurement of some systems. The Army's procurement request of $1.5 billion includes funds for additional Stinger missile launchers to replace the cancelled Hellfire launchers.
- Army budget requests after 2022 anticipated $693.3 million in development funds for DE M-SHORAD. By 2025 the Army had decreased its total requests to $431.3 million, reflecting completion and delivery of prototypes and other activities.
- Similarly, while the Army anticipated requesting $507.6 million in development funding for NGSRI, by 2025 the Army had requested only $373.7 million for development. According to Army officials, the reduction in development funding is due to an Army cost estimate that resulted in lower than originally projected costs, and the savings were realigned to support other programs.

Indirect Fire Protection Capability (IFPC) Increment 2

IFPC Increment 2 provides short-range capability to defeat subsonic cruise missiles, uncrewed aircraft systems, and other aerial threats. It includes the IFPC launcher, an existing sensor, and an existing fire control system.

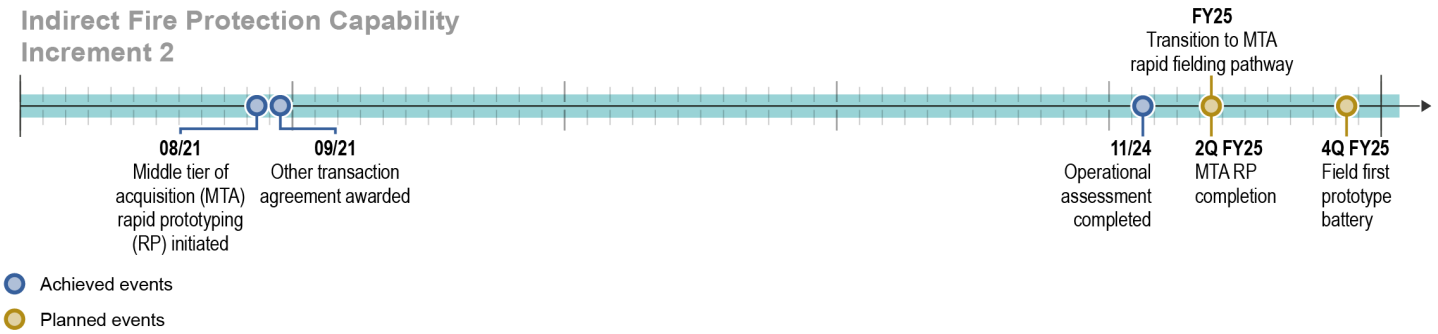
Source: U.S. Army. | GAO-25-107491

IFPC Increment 2 was initiated under the MTA rapid prototyping pathway and is intended to provide short-range air defense against aerial threats.[29] Figure 7 shows a timeline of selected events for the effort.

[28]In 2021, the Army requested $1.1 billion in aggregate for the development of multiple capabilities associated with M-SHORAD. The Army requested separate funding for the increments of M-SHORAD starting with the 2022 budget request.

[29]IFPC Increment 1 is the Land-based Phalanx Weapon System. IFPC Increment 1 is not one of the air and missile defense modernization efforts, and we did not evaluate it for this report.

Figure 7: Indirect Fire Protection Capability Increment 2 Selected Events Timeline



Q = Quarter; FY = Fiscal Year

Source: GAO analysis of Department of the Army documentation. | GAO-25-107491

The Army awarded an other transaction agreement for prototyping to Dynetics, Inc. in September 2021, and Army officials told us they plan to award a FAR-based contract for production. According to Army officials, IFPC Increment 2 is scheduled to issue prototypes to multiple Air Defense Artillery battalions in the fourth quarter of fiscal year 2025. The Army delayed IFPC Increment 2's MTA completion and entry into production by more than a year, but the effort is expected to complete prototyping activities within the 5-year MTA requirement. Officials further stated that the Army is on track to field the first IFPC launchers to support operations in the Indo-Pacific. The Army is also developing a new missile for IFPC Increment 2 on the MTA rapid prototyping pathway, and officials told us they intend to release a request for ideas from potential vendors in the first quarter of fiscal year 2025.

In the 2021 budget request, the Army anticipated requesting $2.2 billion for IFPC Increment 2 from fiscal years 2021 through 2025, of which $870.5 million was to develop the capability and $1.4 billion to procure it. By 2025, the Army had requested $2.1 billion, which consisted of an increase in requests for development funding to $935.2 million and a reduction in procurement funding requests to $1.1 billion. These changes reflect the need for additional testing.

Indirect Fire Protection Capability (IFPC) High Energy Laser (HEL) and High Power Microwave (HPM)

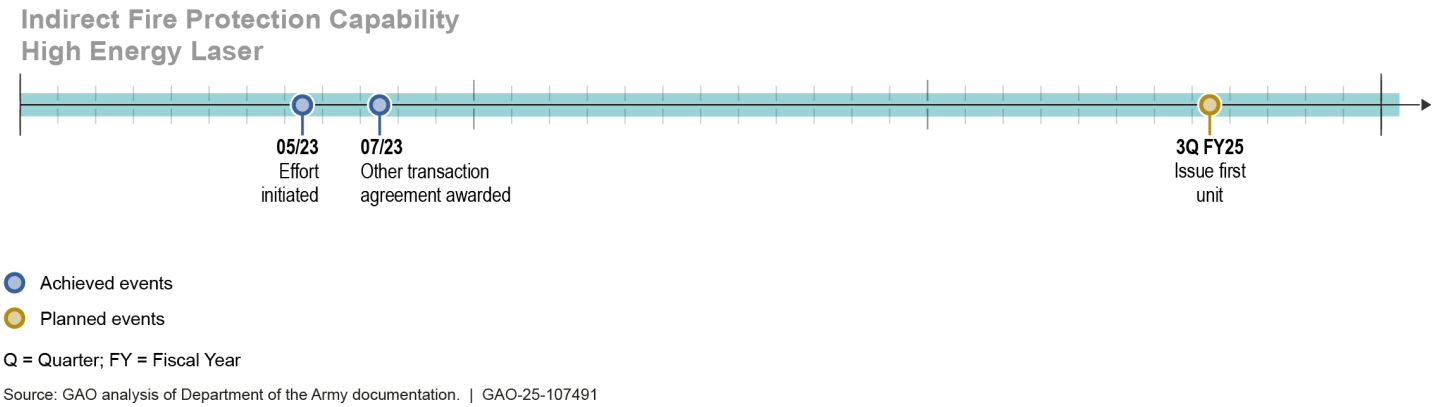
IFPC HEL is a 300 kilowatt-class laser weapon that defends against a variety of air and artillery threats.

IFPC HPM is a high-power microwave system that defends against small-Unmanned Aircraft Systems.

Source: Lockheed Martin Aculight (IFPC HEL) and U.S. Army (IFPC HPM). | GAO-25-107491

IFPC HEL and HPM are under development with Army RCCTO using its prototyping authority. The first directed energy variant is IFPC HEL. Figure 8 shows a timeline of selected events for IFPC HEL.

Figure 8: Indirect Fire Protection Capability High Energy Laser Selected Events Timeline



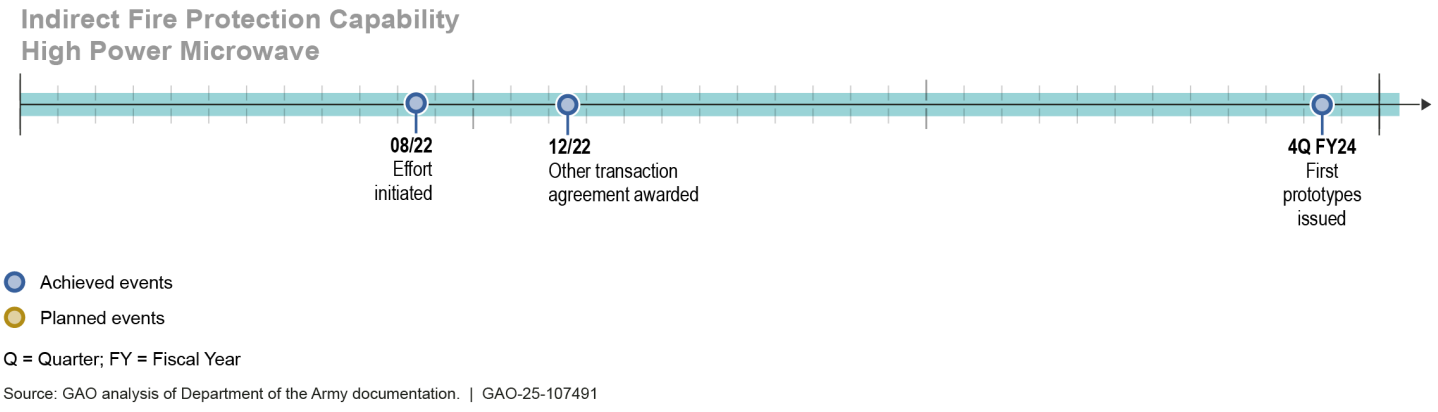
Q = Quarter; FY = Fiscal Year

Source: GAO analysis of Department of the Army documentation. | GAO-25-107491

The Army awarded an other transaction agreement for prototyping to Lockheed Martin in July 2023. RCCTO officials told us that IFPC HEL's planned transition a program office has been delayed and the effort may not transition at all. According to officials, the Army decided to delay the transition and extend prototype testing to gather and evaluate data, including integration with IBCS and assessments from users, to better inform whether to continue investing in the effort. Additionally, they told us that early subsystem-level testing revealed that integration of the associated technologies is more complex than the Army anticipated.

The second directed energy variant is IFPC HPM. See figure 9 for a timeline of selected events for IFPC HPM.

Figure 9: Indirect Fire Protection Capability High Power Microwave Selected Events Timeline



Q = Quarter; FY = Fiscal Year

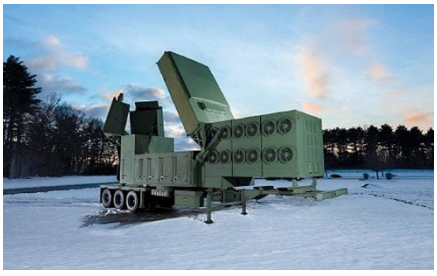
Source: GAO analysis of Department of the Army documentation. | GAO-25-107491

The Army began development of IFPC HPM in August 2022 under RCCTO's prototyping authority. The effort awarded an other transaction agreement for prototyping to Epirus, Inc. in December 2022. IFPC HPM planned to deliver four prototype systems for testing to an Air Defense Artillery battalion in the fourth quarter of fiscal year 2024. RCCTO officials stated that plans to transition the effort to a program office are now dependent on Army senior leadership decision to either further invest in or divest of the effort.

The Army first requested funding for IFPC HEL and HPM in 2022. The 2023 budget request for these systems anticipated $358.6 million and $94.1 million in development funds for the respective systems from fiscal years 2022 through 2025. By 2025, Army requests decreased for IFPC HEL to $310.4 million and for IFPC HPM to $93.8 million, reflecting the uncertainty in the efforts following their demonstrations in the field.

Lower Tier Air and Missile Defense Sensor (LTAMDS)

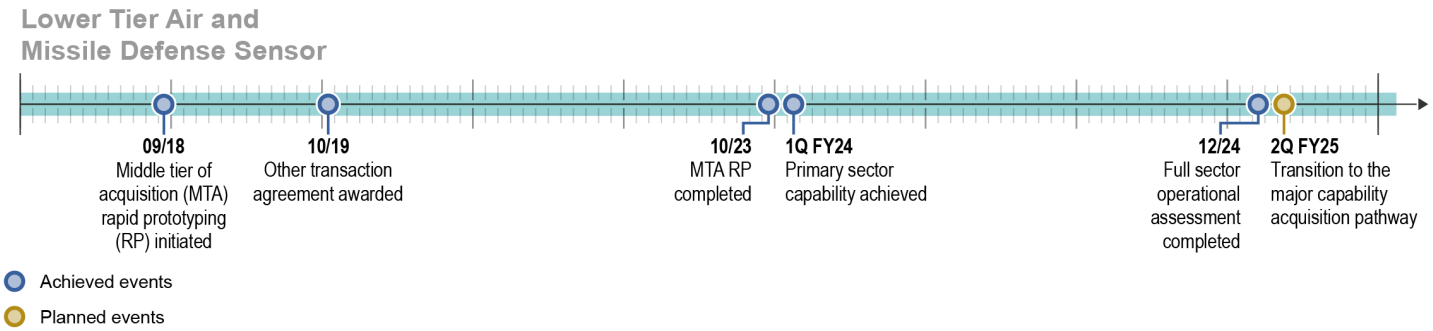
LTAMDS will replace the current Patriot radar. It consists of a 180-degree primary radar component and two secondary radar components that together provide the full 360-degree capability.



Source: Copyright 2020 Raytheon Company. | GAO-25-107491

LTAMDS was initiated on the MTA rapid prototyping pathway by Program Executive Office Missiles and Space in 2018. Figure 10 shows a timeline of selected events for the effort.

Figure 10: Lower Tier Air and Missile Defense Sensor Selected Events Timeline



Q = Quarter; FY = Fiscal Year

Source: GAO analysis of Department of the Army documentation. | GAO-25-107491

The Army awarded an other transaction agreement for prototyping to Raytheon Company in 2019. The Army did not intend to field the primary array capability as an operational configuration and Army officials told us the department has not yet determined when it will field the full array capability. LTAMDS completed its MTA in October 2023 but received approval to delay its production decision and transition to the MCA pathway to the second quarter of fiscal 2025. The last event required before transition to the MCA pathway was the full array operational assessment, which officials stated was completed in December 2024. Army officials told us that in the second quarter of fiscal year 2025, the Army acquisition executive approved the entry of LTAMDS into the MCA pathway pending completion of a revised test plan and supporting program documentation. As of March 2025, LTAMDS officials were working to complete these tasks.

In the 2021 budget, the Army anticipated requesting $1.1 billion in development funds for LTAMDS over 5 years. Additionally, in 2022, the Army first requested procurement funding and by 2023 it anticipated requesting funds totaling $1 billion for procurement through fiscal year 2025. By fiscal year 2025, the Army had requested a total of $2.6 billion, increasing development fund requests to about $2.1 billion and decreasing procurement requests to approximately $572.4 million. This change in funding requests reflects the Army's need for continued testing of LTAMDS and the delay in the production decision.

According to Army officials, in 2022, the Army added **Counter-small Unmanned Aircraft Systems (C-sUAS)** to the air and missile defense modernization portfolio. C-sUAS systems detect, identify, and defeat small (up to 1,320 pounds) uncrewed aircraft threats through a variety of capabilities, including radars, kinetic weapons, and electronic warfare technology. In response to these threats, the Army initially emphasized acquisition of commercially available solutions to address the immediate risk. To further mitigate this evolving threat, the Army is pursuing six C-sUAS formal acquisition programs (see fig. 11).

Figure 11: Counter-small Unmanned Aircraft Systems (C-sUAS) Formal Acquisition Programs

Source: GAO review of Department of the Army information; (U.S. Army images). | GAO-25-107491

The Army designated five of the six systems—FS-LIDS, M-LIDS, Coyote, the Ku-Band Radio Frequency System Family of Radars, and Handheld/Dismounted Systems—as formal acquisition programs within the C-sUAS portfolio in fiscal year 2022. These programs entered the MCA pathway at full-rate production in fiscal year 2024. The Family of Counter-UAS Systems began in response to a 2019 Special Operations Rapid Requirement Document and transferred to RCCTO in February 2021. The Family of Counter-UAS Systems transitioned to the Urgent Capability Acquisition pathway under a project office to become a formal acquisition program in July 2024, following development of six prototypes and completion of an operational assessment that involved soliciting user feedback. All six formal programs are using FAR-based contracts for production. Army officials told us that FAR-based contracts are easier to set up than other transaction agreements for production because they have previous experience using them and these types of contracts include specific required language.

Army officials told us that they work to deliver capabilities to the field as quickly as possible and will deliver initial systems with the intention of developing additional capabilities in the future. As a result, some of the C-sUAS formal acquisition programs are continuing to pursue improvements and additional variants. For example, according to officials, FS-LIDS has initiated development efforts to reduce the number of boxes needed to contain the system's hardware. M-LIDS is developing a single vehicle variant, using a Stryker

platform with both kinetic and electronic warfare capabilities that will replace the current two-vehicle configuration. Officials also told us they are developing a faster Coyote variant, Coyote 2C to keep pace with evolving threats.

The Army C-sUAS Project Office also leverages commercial and government off-the-shelf solutions to deliver capability to the soldier quickly. For example, officials told us that they are not conducting development efforts for Handheld/Dismounted capabilities because their effectiveness has a short lifespan. Rather, to respond to the speed at which evolving small uncrewed aircraft threats are rendering systems obsolete, the Army constantly tests and procures Handheld/Dismounted systems from commercial vendors with a warranty period of 24-36 months. The Army replaces them with more current technology when the warranty expires rather than sustain them. Leveraging both developmental and off-the-shelf solutions ensures that the Army can continuously provide updated solutions to the soldier to keep pace with the evolving threat.

Army funding requests for C-sUAS systems have increased significantly since the Army dedicated a funding line specifically for these systems starting in 2022. Since that time, funding requests increased from an anticipated request of $551.5 million to approximately $1.2 billion by 2025. During this time, requests for procurement increased from $473 million to $1 billion.

The Army Did Not Consistently Apply Leading Practices, Including Modern Design Tools, For Air and Missile Defense Modernization Efforts

The Army varied in its approach to developing the seven air and missile defense modernization efforts, and did not consistently apply leading practices for product development. None of the efforts, however, are fully leveraging modern design tools, such as the use of digital twins and digital threads.

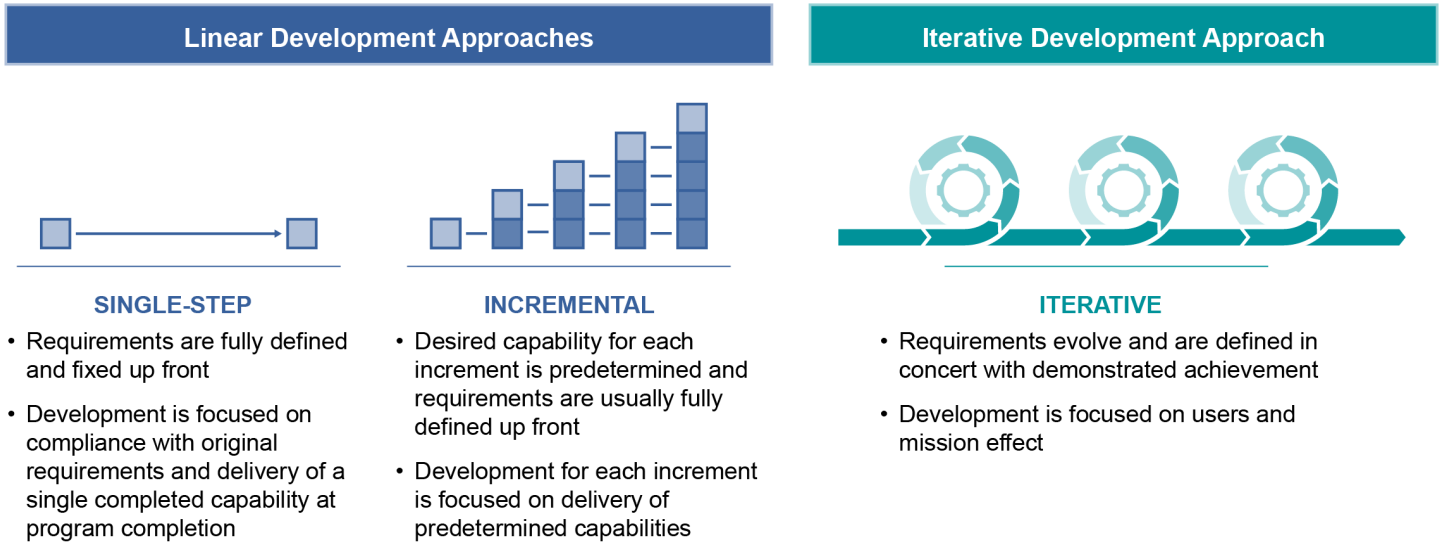
Most Air and Missile Defense Modernization Efforts Did Not Consistently Apply an Iterative Development Approach

Two of the seven air and missile defense modernization efforts applied an iterative development approach, while the remaining five efforts did not. Leading practices we identified for product development identify that leading companies employ an iterative development approach when developing complex products. The iterative development approach involves a continuous cycle, through which companies evaluate iterations of capability on functionality, quality, and customer satisfaction to increase innovation and speed delivery.[30] Conversely, traditional development approaches for hardware and software products progressed through a lengthy, linear process with sequential milestones. Companies solidified requirements before development start and delivered capability either in a single completed product at the end of the development cycle or incrementally, with each increment delivering a predetermined capability.

[30]GAO-23-106222 and GAO-22-104513.

Figure 12 below compares these two development approaches.

Figure 12: Comparison of Linear and Iterative Development Approaches



Source: GAO assessment of Defense Acquisition University information and GAO-23-106222. | GAO-25-107491

Our review of the seven air and missile defense modernization efforts identified that two efforts—IBCS as well as IFPC HEL and HPM—used iterative development:

- **IBCS** is using an iterative development approach with continuous cycles to develop, test, and collaborate with users to establish and continuously evaluate its business case as well as deliver updates to its minimum viable product. Prior to 2019, the Army was leveraging an incremental development approach. As part of its incremental approach the Army performed analysis in 2009 to inform its business case and support development of requirements for the system. After the Army restructured IBCS to follow the Software Acquisition pathway in 2021, it moved to an iterative development approach. According to Army officials, in December 2020, the Army re-evaluated the analysis from 2009 that supports its business case, and found the analysis was still valid. Our leading practices for product development state that leading companies start with a sound business case and continuously evaluate elements of the business case.

  In addition, requirements for future IBCS iterations are based on a priority integration list that, according to Army officials, is evaluated at least quarterly in collaboration with users and stakeholders. As part of this evaluation, the effort has off-ramped integration of technology that required further development. For example, Army officials told us that they delayed integration of a targeting system into IBCS as the system required further development to fix critical deficiencies. We previously found that leading companies make off-ramping decisions for a given minimum viable product largely based on customer and user needs, with the knowledge that they can add some of the capabilities in subsequent iterative product deliveries. Because the iterative process provides such opportunities, leading companies delay capabilities that are not ready until the next release or decide not to provide them if they are no longer needed.[31]

[31]GAO-23-106222 and GAO-22-104513.

According to Army officials, the effort also prioritized user interaction with each iteration of IBCS prior to fielding. During this testing, users provided feedback that is being used to make changes within the system as well as identify what capabilities would be of most utility to the user in future iterations. Leading practices we identified for product development identify that leading companies establish a process to facilitate ongoing engagement with users to inform design specifications. This user-centered design process means that information gathered from users leads to building, testing, and redesigning through rapid iterations and innovation until the product specifications meet user needs.

- **IFPC HEL and HPM** variants applied iterative development approaches. In developing the business case for these two IFPC variants, the Army leveraged analysis to develop high-level operational needs in a draft A-CDD for each system. These documents have allowed the Army to conduct prototyping activities for each system. The Army will identify and refine detailed requirements during iterative development to arrive at what developers and users will agree upon as a minimum viable product for each system. We found that the Army's approach of starting with an A-CDD, and subsequently refining requirements generally aligned with leading companies, which do not attempt to start development with a business case that includes a detailed specification of requirements. Instead, development begins with a high-level need statement or idea, which is continuously refined into distinct requirements through iterative development cycles. In this manner, leading companies enable the initial business case to evolve throughout product development.

  After determining the desired characteristics for IFPC HEL and HPM, RCCTO is performing iterative cycles to develop, test, and collaborate with users. For example, the Army performed multiple developmental tests with the HPM variant by using soldiers in the field to solicit user feedback which, according to Army officials, they intended to incorporate into changes to the design. The Army's actions for IFPC HEL and HPM align with leading practices for product development, which state that leading companies seek and obtain continuous user feedback throughout iterative development.[32]

We found that four air and missile defense modernization efforts—M-SHORAD, DE M-SHORAD, IFPC Increment 2, and LTAMDS—used linear development approaches that, at times, reflected some characteristics of an iterative development approach.

- The overall **M-SHORAD** effort—including **DE M-SHORAD**—used an incremental, linear development approach consisting of five increments. According to Army officials, before starting development, the Army determined what characteristics it would seek for each of the five increments. Each increment will provide the Army with short-range air defense systems with similar characteristics but the desired capabilities for some increments varied. As previously mentioned, the Sgt. Stout platform is based on a Stryker vehicle and NGSRI is a new missile that is intended to reside on a Sgt. Stout platform as well as have a soldier-portable capability. While DE M-SHORAD is also mounted on a Stryker vehicle, it requires a different design and technologies for a directed energy solution as its primary armament. The Army plans for Increments 4 and 5 will not use the Stryker as the base vehicle and instead will use other vehicles that are currently in the Army's portfolio according to officials. This will require different designs to accommodate a short-range air defense capability for these vehicles.

  While this developmental approach allows the Army to develop multiple increments of capability for the soldier, it does not fully meet leading practices we identified for product development. The Army, in pre-determining capabilities for each increment of M-SHORAD, did not iteratively develop the system with users to determine which capabilities would be of most operational value.

[32]GAO-23-106222 and GAO-22-104513.

The effort's incremental, linear development approach, however, contains elements resembling aspects of an iterative design process. For example, while the effort's business case was predicated on a directed requirement rather than on collaboration with users, Army officials told us they obtained input on requirements from a user representative, an Army Capability Manager. This input, along with the directed requirements that were derived from an operational need identified by Army leadership in Europe, allowed the Army to get feedback on requirements for the system from users at the operational level. As development has progressed for the first three M-SHORAD increments, the Army has engaged in ongoing feedback with end users. For example, NGSRI planned multiple soldier touchpoints throughout development. Army officials stated the user feedback informs system requirements. Leading practices for product development state that obtaining ongoing feedback from customers for a potential product is an important aspect to attaining a sound business case for leading companies. In soliciting early feedback from a user representative to develop requirements, as well as ongoing feedback from users to inform requirements, M-SHORAD implemented a process similar to what would occur under an iterative development approach.

- **IFPC Increment 2** leveraged incremental, linear development to develop a minimum capability to field to the soldier. For IFPC, the Army plans to develop Increment 2, as well as at least one future increment focused on replacement of the current missile with a next generation missile. The requirements for Increment 2 and the new missile were not identified through an iterative design process based on user feedback and design modeling and simulation. Instead, the requirements for both increments were predetermined prior to the start of development. In addition, for Increment 2, the Army sought a specific materiel solution that was identified prior to initiating the effort. Leading practices for product development identified that leading companies work together with users to define requirements, which, in turn, inform the selected solution.

  IFPC Increment 2's incremental development approach reflects at least one aspect of an iterative development approach. When the Army established its business case for IFPC Increment 2 it relied on a user representative, an Army Capability Manager, to provide user feedback at the operational level on requirements. In doing so, the Army incorporated user feedback early in the requirements development process, similar to what would occur under an iterative development approach. In addition, IFPC Increment 2 is leveraging soldier touchpoints throughout development to identify changes on the design of the system. Army officials stated that this feedback can also be used to make changes to the system's requirements to better reflect user needs, among other items. Our leading practices for product development found that leading companies seek and obtain continuous user feedback throughout development. This feedback helps determine if the design is meeting user needs and reflects a minimum viable product.

- **LTAMDS** followed a single-step, linear development approach. LTAMDS established its business case through market research and input from an Army Capability Manager who provided operational user feedback. Using this business case, the Army set requirements for the system prior to starting development that required a 360-degree radar functionality. Under this single-step, linear development approach, the LTAMDS effort sought to meet these specific requirements. For example, while the effort achieved partial functionality—a 180-degree radar capability—the Army determined it would not field the systems until it achieved a 360-degree radar functionality. We previously found that leading companies refine capabilities to a minimum set that provides value to the customer and can be delivered quickly while deferring capabilities that are less urgent or not mature. The Army, in defining set requirements, did not develop minimum system capabilities. Further, the Army decided not to field the 180-degree radar as a minimum capability and, according to Army officials, does not plan to iterate on this capability in conjunction with the end user, as would be seen in an iterative development approach. As a result, while the LTAMDS

development approach allowed the Army to seek a solution to address the identified capability need, it does not fully meet our leading practices for product development.

The last effort, **C-sUAS**, primarily focused on integration and procurement as opposed to iterative or linear product development. In this capacity, the various C-sUAS efforts generally sought mature solutions that could be quickly integrated or procured to fulfill user operational needs. To ensure these capabilities are meeting user needs, Army officials told us they conducted weekly videoconferences with soldiers in the field to solicit feedback that is being used to make changes to requirements or identify future capabilities.

As these efforts have been fielded, the C-sUAS office has started to explore new capabilities. Officials stated that they will first seek commercially available solutions for the new capabilities, but in the absence of a viable commercial solution, the Army plans to start some developmental efforts. For example, Army officials told us the office plans to develop the M-LIDS system so it can be mounted on multiple types of Army vehicles. These officials further stated that the C-sUAS program plans to start other developmental efforts in fiscal year 2026.

At present, most DOD acquisition programs and efforts, including the Army's, are not required to implement an iterative development approach. We previously found that DOD policies include multiple examples that emphasize iterative development. In many cases, however, we found that policy language was limited to certain acquisitions—such as software—and did not generally apply across all acquisition programs and efforts.

In 2022, we made four recommendations including that DOD update its acquisition policies to fully implement iterative development principles. DOD concurred with our recommendations and noted that it will consider implementing the leading product development principles when it next updates its acquisition policies.[33] Such policies would better position programs and efforts to evaluate iterations of capability on functionality, quality, and customer satisfaction to increase innovation and speed delivery. The absence of such policies does not preclude efforts from implementing iterative development, which could help them prioritize developing and delivering new, innovative products to customers with speed.

Air and Missile Defense Efforts Are Not Fully Using Modern Design Tools that Could Speed Up Development

Regardless of the development approach taken, none of the air and missile defense efforts are fully using modern design tools that could improve development speed. Our prior work found that leading companies benefit from using modern design tools—such as 3D modeling and simulation, digital twins, and digital threads—during the design modeling and simulation cycle.[34] Table 1 identifies characteristics of key modern design tools.

[33]GAO-22-104513. DOD has not updated its acquisition policies to fully incorporate leading practices—including the use of iterative development and modern design tools—that private sector companies use to drive innovation and speed in product development, as we recommended. DOD is updating its Adaptive Acquisition Framework policies, however, one recently updated policy and the draft version of another policy, do not fully incorporate leading practices to achieve positive outcomes. Additionally, although DOD's military departments have issued policies in alignment with DOD's goals and the Adaptive Acquisition Framework, these policies do not consistently reflect leading practices.

[34]GAO-23-106222 and GAO-22-104513.

Table 1: Characteristics of Key Modern Design Tools

	Description	Key characteristics
3D modeling and simulation	A 3D model is a static virtual representation of a system at a given point in time. Digital simulation is used to test the 3D model using predefined data to understand how a system will act in a specific scenario.	A 3D model cannot be updated without someone manually inputting new data and is like paper design drawings in digital form. A digital simulation is bound by the predefined data points within a specific scenario.
Digital twin	A dynamic virtual model that simulates the configuration, performance, and behavior of a system within a computer and can be updated in real time.	A more detailed, dynamic, and complex virtual representation of physical system than a 3D model. Can be updated in real time. Usually connected to a digital thread. Useful in the sustainment phase.
Digital thread	A common source of information that connects stakeholders with real-time data across the product life cycle to help inform decisions.	Data in a digital thread could include the test results from digital twin modeling, user feedback, and records of design changes among other information. Useful in the design and validation process as it can enable more rapid iterative design cycles and facilitate stakeholder and user feedback at earlier stages.

Source: GAO analysis of Defense Acquisition University and Department of Defense information; GAO-23-106222. | GAO-25-107491

While 3D modeling and simulation and digital twins share some characteristics, the use of a digital twin and associated digital thread offer additional benefits. A high-fidelity digital twin, coupled with high-resolution simulations of the operating environment, can be used for testing the system to validate that it meets requirements. This reduces the need to build physical prototypes each time the design changes. We previously found that, at leading companies, digital twins allowed for faster design iterations and quicker delivery of a product to the user than design and development without these tools. Leading companies continually feed data from the digital twin into a real-time digital thread, which they then use to inform decision-making, such as how to refine requirements or whether to make certain changes to the product's design.

Our review of the air and missile defense efforts determined that six of the seven efforts used 3D modeling and simulation. Most of the efforts, however, do not plan to use digital twins or digital threads. Specifically:

- **IBCS** used 3D modeling and simulation during development. According to Army officials, the effort also has a digital thread they maintain within a database that captures all programmatic decisions and information related to the effort. Army officials further clarified that the effort does not have a digital twin for the hardware associated with IBCS, and there are no plans to develop one.
- **M-SHORAD** effort used 3D modeling and simulation for development of Sgt. Stout and NGSRI. Army officials told us the effort does not have a digital twin or digital thread for either of these increments. For example, NGSRI will develop a digital twin for the missile, but officials stated that they will not develop a full system-level digital twin to include the launcher and the vehicles due to funding constraints. According to Army officials there are no requirements or plans to develop system-level digital twins or a digital thread for any of M-SHORAD's increments.
- **DE M-SHORAD,** according to Army officials, used 3D modeling and simulation for development but does not have a digital twin or digital thread. Officials also stated there are no requirements or plans to develop system-level digital twins or a digital thread.

- **IFPC Increment 2** only used 3D modeling and simulation. Army officials told us that IFPC Increment 2 does not have a digital twin or a digital thread and there are no plans to develop either for the effort because of the significant cost and labor involved.
- **IFPC HEL and HPM** used 3D modeling and simulation. Army officials stated that the vendor for HEL has a digital twin of one component, but the effort does not have a full system-level digital twin. These officials also stated that RCCTO is developing a digital thread for IFPC HEL, but it is not accessible to the contractor without government permission. Due to limitations in who can access this information, the RCCTO-developed digital thread is not an authoritative source of information available to all stakeholders, as defined by our leading practices. In addition, officials told us that they are not developing a digital twin or digital thread for IFPC HPM prototypes due to cost but may do so in the future if the Army decides to proceed with further development.
- **LTAMDS** used 3D modeling and simulation during development. Army officials told us that the effort is developing a digital twin and plans to develop a digital thread.
- Army officials told us the **C-sUAS** programs have not used many modern design tools due to the limited development activities. These officials clarified that only one C-sUAS program, the Coyote interceptor, has leveraged modern design tools. Coyote is working to build some models and simulations using data from its test events. In addition, Army officials told us they are assessing the use of digital twins and a digital thread for Coyote but have not yet used either. Army officials further told us that the C-sUAS effort is working to increase the use of modern design tools for all efforts starting in fiscal year 2026 and has started to include language in contracts and other transaction agreements requiring the use of these tools.

DOD issued a policy in December 2023 that requires efforts initiated after that date to incorporate modern design tools.[35] The policy also states that existing efforts, such as the air and missile defense efforts, may incorporate modern design tools when it is practical, beneficial, and affordable, but they are not required to do so under the policy. The Army also has a policy that encourages the use of modern design tools, but it does not contain a requirement for programs to use it.[36] According to Army officials, the department recognizes both the benefits of using modern design tools and that it is difficult to implement these tools in many programs. These officials further stated that modern design tools is a newer area that requires the Army to adapt many of its processes to fully implement it across the department. As a result, most Army programs and efforts are not required to implement modern design tools under current Army policy.

Our past work highlighted that leading companies use modern design tools like digital twins and digital threads early in the development process. The use of these tools provides the ability to implement iterative development faster than what would be possible with physical prototypes alone.[37] The effectiveness of modern design tools is best achieved under an iterative development approach. Efforts that use a linear approach may be able to realize some efficiencies, especially in sustainment.

The Army initiated the seven air and missile defense modernization efforts prior to DOD and the Army updating their respective policies for the increased use of modern design tools. None of the seven efforts currently plan to fully implement use of modern design tools. Consequently, the air and missile defense modernization efforts may not be taking full advantage of the efficiencies that modern design tools can provide. Given the new policy

[35]Department of Defense, *Digital Engineering*, DOD Instruction 5000.97 (Dec. 21, 2023).

[36]Department of the Army, *Army Digital Engineering,* Army Directive 2024-03 (May 21, 2024).

[37]GAO-23-106222 and GAO-22-104513.

introduced by DOD in December 2023, a formal, documented assessment of whether and how to implement these tools would allow each effort to identify whether these tools are beneficial, practical, and affordable to use.

Conclusions

After placing limited emphasis on its air and missile defense portfolio for several decades, the Army is spending billions of dollars to modernize its systems to address identified capability needs. Yet, even with the use of accelerated acquisition approaches and increases in funding, the Army, outside of C-sUAS, has fielded limited capabilities—Sgt. Stout to operational units and IBCS to operational users for further testing. Other air and missile defense systems will not be fielded to operational units for years to come. Most air and missile defense efforts did not consistently apply an iterative development approach that enables continuous development cycles to rapidly develop and deliver essential capabilities to soldiers. The Army also does not intend to use iterative development for the air and missile defense modernization efforts it has planned for the future. The expanded use of modern design tools, such as 3D modeling and simulation, digital twins, and digital threads, would help all the air and missile defense modernization efforts to iterate more quickly on designs than is possible with 3D modeling and simulations alone, speeding delivery of capability to the soldier. The Army may be missing opportunities for quicker delivery of capabilities if it does not assess the practicality, benefits, and affordability and subsequently adopt modern design tools across its air and missile defense modernization efforts.

Recommendations for Executive Action

We are making the following six recommendations to DOD:

The Secretary of the Army should ensure that Maneuver-Short Range Air Defense Increments 4 and 5, which incorporates new vehicle platforms, follows an iterative product development approach. (Recommendation 1)

The Secretary of the Army should ensure that development of the new missile for the Indirect Fire Protection Capability follows an iterative product development approach. (Recommendation 2)

The Secretary of the Army should ensure that the Integrated Battle Command System program assesses the practicality, benefits, and affordability of implementing a digital twin that incorporates both software and hardware. (Recommendation 3)

The Secretary of the Army should ensure that Maneuver-Short Range Air Defense Increments 1, 2, and 3 efforts—Sgt. Stout, Directed Energy, and Next Generation Short Range Interceptor, respectively—assess the practicality, benefits, and affordability of implementing modern design tools, including digital twinning and digital threads. (Recommendation 4)

The Secretary of the Army should ensure that all variants of the Indirect Fire Protection Capability effort—to include the development of subsystems for Increment 2 as well as the High Energy Laser and High-Power Microwave efforts—assess the practicality, benefits, and affordability of implementing modern design tools, including digital twinning and digital threads. (Recommendation 5)

The Secretary of the Army should ensure that the Lower Tier Air and Missile Defense Sensor effort assesses the practicality, affordability, and benefits, of implementing modern design tools, including digital twinning and digital threads. (Recommendation 6)

Agency Comments

We provided a draft of this report to DOD for review and comment. In its comments, reproduced in appendix II, DOD concurred with our six recommendations. They also provided a technical comment which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, the Secretary of the Army, and other interested parties. In addition, the report is available at no charge on the GAO website at https://www.gao.gov/.

If you or your staff have any questions about this report, please contact me at sehgalm@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix III.

//SIGNED//

Mona Sehgal
Director, Contracting and National Security Acquisitions

List of Committees

The Honorable Roger F. Wicker
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Mitch McConnell
Chair
The Honorable Christopher Coons
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Mike Rogers
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Ken Calvert
Chairman
The Honorable Betty McCollum
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Objectives, Scope, and Methodology

A Senate report and the House report accompanying the National Defense Authorization Act for Fiscal Year 2024 include provisions for us to review and assess the Army's air and missile defense modernization efforts.[1] Our report (1) describes how the Army developed the requirements to support its modernization of air and missile defense programs and efforts, (2) describes how the Army is acquiring the systems to modernize its air and missile defense programs and efforts, and (3) assesses the extent to which the Army's applied leading practices for product development for its air and missile defense modernization programs and efforts.

For the first objective, we reviewed the Army's requirements process and applicable documents, such as directed requirements, abbreviated capability development documents, and capability development documents. This allowed us to understand how the Army identified the capabilities it needed and developed the requirements for systems in development. Our review of documents also included Army studies that informed its modernization efforts.

For the second objective, we reviewed the Army's acquisition approaches for systems identified in the Army's 2021 Modernization Strategy and for Counter-small Unmanned Aircraft Systems. We focused on the 2021 Army Modernization Strategy for our review because Army officials said it identified the Army's 35 signature modernization efforts, six of which were for air and missile defense. We also focused on Counter-small Unmanned Aircraft Systems for our review, which Army officials told us the department added as a modernization effort in 2022. We reviewed acquisition plans and program status updates.

Additionally, we reviewed changes to Army budget requests and their associated schedules since fiscal year 2021. Specifically,

- To identify the acquisition approaches the Army is using to acquire its air and missile defense modernization efforts, we reviewed Army documents, such as simplified acquisition management plans, acquisition decision memorandums, and budget briefing documents. To identify the agreement types the Army is using to acquire its air and missile defense modernization efforts, we reviewed documents that identified the other transaction agreements and Federal Acquisition Regulation (FAR)-based contracts that the efforts are using for prototyping and production. We interviewed Army officials to discuss the benefits and challenges of using other transaction agreements as opposed to FAR-based contracts for prototyping and production. We also interviewed Army officials to understand why the Army chose these acquisition approaches. We reviewed the air and missile defense modernization efforts' schedules to identify when key events occurred or are planned to occur. We interviewed Army officials to determine why delays, if any, occurred and how they are expected to affect the effort's future development.
- We reviewed the fiscal years 2021 through 2025 President's Budget requests for research, development, test, and evaluation, and procurement. This allowed us to identify the amount of funding the Army included in its annual budget submission to Congress for each of its air and missile modernization efforts, as well as the total across all air and missile defense systems. We compared the Army's projected 5-year funding request in 2021 for fiscal years 2021 through 2025 with what subsequent budget submissions requested to determine how funding requests changed over time. We spoke with Army officials to understand the

[1]S. Rep. No. 118-58, at 18 (2023); H. Rep. No. 118-125 at 6 (2023); and National Defense Authorization Act for Fiscal Year 2024, Pub. L. 118-31 (2023).

reasons for the changes in individual efforts and programs as well as the total air and missile defense budget and how they expect funding for air and missile defense to change in the future. We did not analyze the underlying cost estimates developed for each air and missile defense system. We found the data to be sufficiently reliable for the purposes of reporting the amounts the Army requested for its air and missile defense efforts.

For the third objective, we assessed whether each air and missile defense effort's development approach was linear or iterative and discussed applicable leading practices that we identified in prior work for product development for each effort.[2] To identify the development approach for each air and missile defense modernization effort, we reviewed Army documentation and interviewed Army officials from each effort, as well as Army Futures Command and the Army Rapid Capabilities and Critical Technologies Office. To determine the extent to which the Army applied leading practices for product development, we reviewed documents provided by the Army and interviewed officials from the five offices overseeing development of the efforts. These documents included acquisition decision memorandums and simplified acquisition management plans, among others. We also reviewed Department of Defense (DOD) and Army instructions and guidance for digital engineering and interviewed DOD and Army officials such as the Deputy Assistant Secretary of the Army for Data, Engineering, and Software.

For each of the objectives, in addition to the documentary evidence that we analyzed by objective above, we conducted interviews with DOD and Army officials on the Army's air and missile defense requirements development process, acquisition efforts, the President's Budget requests, and use of leading practices for product development. We conducted in-person interviews with air and missile defense requirements and program offices at Fort Sill, Oklahoma and Redstone Arsenal, Alabama, the only two offices that provide such support.

We also interviewed DOD and Army officials from the following organizations:

- Office of the Secretary of Defense
  - Under Secretary of Defense for Acquisition and Sustainment
  - Under Secretary of Defense for Research and Engineering
  - Office of the Director, Operational Test and Evaluation
  - Office of Cost Assessment and Program Evaluation
- DOD Joint Counter-small Unmanned Aircraft Systems University
- DOD Joint Counter-small Unmanned Aircraft Systems Office
- Assistant Secretary of the Army (Acquisition, Logistics, and Technology)
  - Deputy Assistant Secretary of the Army for Data, Engineering, and Software
  - Program Executive Office Missiles and Space
    - Short and Intermediate Effectors for Layered Defense Project Office

[2]GAO, *Leading Practices: Iterative Cycles Enable Rapid Delivery of Complex, Innovative Products*, GAO-23-106222 (Washington, D.C.: July 27, 2023); and *Leading Practices: Agency Acquisition Policies Could Better Implement Key Product Development Principles*, GAO-22-104513 (Washington, D.C.: Mar. 10, 2022).

    - Integrated Fires Capabilities Office—Counter-small Unmanned Aircraft Systems
    - Search, Track, Acquire, Radiate, Eliminate Project Office
    - Integrated Fires Mission Command Project Office
- Headquarters, Department of the Army G-8, Programs
- Headquarters, Department of the Army G-3/5/7 Fires
- Army Test and Evaluation Command
- Army Futures Command
    - Air and Missile Defense Cross-Functional Team
    - Fires Capabilities Development and Integration Directorate
    - Combat Capabilities Development Command—Aviation and Missile Center
    - The Research and Analysis Center
- Army Rapid Capabilities and Critical Technologies Office
    - Directed Energy Project Office
    - Rapid Acquisition Prototyping Project Office

We conducted this performance audit from March 2024 to June 2025 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comments from the Department of Defense

Secretary of the Army
Washington

22 May 2025

Ms. Mona Sehgal
Director
Contracting and National Security Acquisitions
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Ms. Sehgal:

This is the Department of Defense (DoD) response to the GAO Draft Report, GAO-25- 107491, "ARMY MODERNIZATION: Air and Missile Defense Efforts Would Benefit from Applying Leading Practices, dated May 2025 (GAO Code 107491).

The DoD concurs with the draft report.

The DoD appreciates the opportunity to review the draft report. My point of contact is Mr. Edison Hammond, Office of the Assistant Secretary of the Army (Acquisition, Logistics, and Technology), edison.l.hammond.civ@army.mil or 703-545-1622.

Dan Driscoll

Enclosures

Enclosure 1

GAO DRAFT REPORT, GAO-25-107491, DATED APRIL 14, 2025 (GAO CODE 107491)

“ARMY MODERNIZATION: AIR AND MISSILE DEFENSE EFFORTS WOULD BENEFIT FROM APPLYING LEADING PRACTICES”

DEPARTMENT OF THE ARMY (DA) COMMENTS

GAO recommendation 1: The Secretary of the Army should ensure that Maneuver- Short Range Air Defense (M-SHORAD) increments 4 and 5, which incorporates new vehicle platforms, follows an iterative product development approach.

DA response: The Army concurs with this recommendation.

GAO recommendation 2: The Secretary of the Army should ensure development of the new interceptor for the Indirect Fire Protection Capability follows an iterative product development approach.

DA response: The Army concurs with this recommendation. The Indirect Fire Protection Capability is also known as the Integrated Fire Protection Capability.

GAO recommendation 3: The Secretary of the Army should ensure that the Integrated Battle Command System program assesses the practicality, benefits and affordability of implementing a digital twin that incorporates both software and hardware.

DA response: The Army concurs with this recommendation.

GAO recommendation 4: The Secretary of the Army should ensure that the M- SHORAD Increments 1, 2 and 3 efforts—Sgt. Stout, Directed Energy, and Next Generation Short Range Interceptor respectively—assess the practicality, benefits and affordability of implementing digital engineering, including digital twinning and digital threads.

DA response: The Army concurs with this recommendation.

GAO recommendation 5: The Secretary of the Army should ensure that all variants of the Indirect Fire Protection Capability effort—to include the development of subsystems for Increment 2 as well as the High Energy Laser and High-Power Microwave efforts—

assess the practicality, benefits, and affordability of implementing modern design tools, including digital twinning and digital threads.

DA response: The Army concurs with this recommendation.

GAO recommendation 6: The Secretary of the Army should ensure that the Lower Tier Air and Missile Defense Sensor effort assess the practicality, benefits, and affordability of implementing modern design tools, including digital twinning and digital threads.

DA response: The Army concurs with this recommendation.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the contact named above, J. Kristopher Keener (Assistant Director), Joe E. Hunter (Analyst-In-Charge), Erin Carson, Christopher Durbin, Megan Ferren, Stephanie Gustafson, Simon Messineo, Mark Oppel, Andrew N. Powell, and Adam Wolfe made significant contributions to this review. Other contributors include Jennifer Leotta, Jean McSween, Kevin O'Neill, and Justin Snover.

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