May 2022

GPS MODERNIZATION

Better Information and Detailed Test Plans Needed for Timely Fielding of Military User Equipment

Accessible Version

GAO Highlights

May 2022
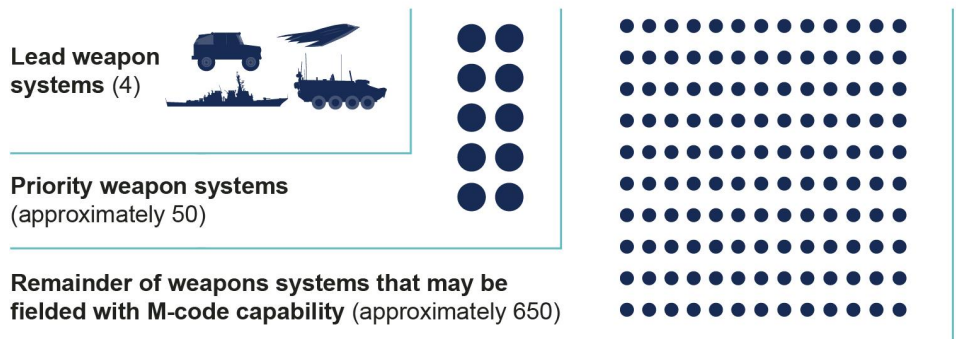
GPS MODERNIZATION

Better Information and Detailed Test Plans Needed for Timely Fielding of Military User Equipment

Why GAO Did This Study

The Air Force launched the first GPS satellite capable of broadcasting the jam-resistant M-code signal in 2005. However, delays have plagued the ground and user equipment segments needed to take advantage of the technology.

The Senate Report accompanying the National Defense Authorization Act for Fiscal Year 2020 included a provision for GAO to report on the status of GPS modernization. This report assesses, among other things, the extent to which DOD has identified systems to field with M-code-capable equipment, and its plans for the procurement, installation, and fielding of this equipment. GAO reviewed DOD's plans for GPS and DOD's data repository on GPS modernization, and interviewed DOD officials.

What GAO Recommends

GAO is making seven recommendations to DOD, including that DOD and the military services ensure information in their GPS modernization database is sufficient to support priorities for planning for and fielding M-code, and that they validate this information regularly. GAO also recommends that the military services finalize operational test plans for priority weapon systems once M-code equipment is available. DOD concurred with three recommendations and partially concurred with the remaining four. In keeping with the findings in this report, GAO updated those recommendations based on suggestions DOD provided.

What GAO Found

The Department of Defense (DOD) has been modernizing GPS to use a more jam-resistant, military-specific signal called M-code for more than 2 decades. The Space Force is nearing a key GPS milestone—a constellation of 24 satellites broadcasting the signal. However, while the ground segment that controls the signal will be available in 2023, widespread operational use will take several more years, due to developmental challenges and delays with the user equipment that will receive the signal. DOD's strategy is to test this equipment in lead weapon systems including aircraft, ships, and combat vehicles. DOD has begun to select priority systems for M-code capability, but incomplete data have hindered these efforts. Based on a classified military scenario, DOD selected over 50 systems that will get M-code capability first (see figure). Eventually, DOD plans to incorporate modernized GPS equipment in about 700 weapon systems.

Notional Representation of Services' Weapon Systems for Fielding with M-code
Approximately 700 total weapon systems

Lead weapon systems (4)

Priority weapon systems (approximately 50)

Remainder of weapons systems that may be fielded with M-code capability (approximately 650)

● = 5 weapon system types

Source: GAO representation of Department of Defense information. | GAO-22-105086

DOD maintains a database on modernizing the GPS enterprise—including the types and numbers of GPS receivers that systems will use, projected budget amounts, and time frames. The military services enter the required data. Until mid-2021, the database did not have a field to identify priority systems. Significant issues with data completeness and accuracy remain, in part due to user equipment delays, but also because the database does not have formal data validation. Poor data hinder the congressional defense committees' ability to track the progress of M-code and support DOD decision-making.

User equipment delays have also had ripple effects on DOD's ability to plan for and develop M-code-capable receivers. These delays have limited the military services' ability to fully develop plans for operationally testing the M-code capability; they cannot do so without firm dates for availability of user equipment. Testing will be complex and, once equipment is ready, the services will need sufficient test data to support fielding decisions and user understanding of capabilities. Delays to test plans place timely fielding of M-code capability on priority systems at risk.

United States Government Accountability Office

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Abbreviations

ASIC	application-specific integrated circuit
CIO	Chief Information Officer
DAPS	Dismounted Assured PNT System
DLA	Defense Logistics Agency
DOD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
EAGLE-M	Embedded GPS/Inertial Navigation System/Enhanced Aviation Global Air Traffic Management Localizer Performance Vertical Guidance Embedded GPS Inertial Navigation System – M-Code
EGI-M	Embedded GPS Inertial Navigation System – Modernized
GPNTS	GPS-based Positioning, Navigation, and Timing Service
GPS	Global Positioning System
GPS IIIF	GPS III Follow-On
IPT	Integrated Product Team
JLTV	Joint Light Tactical Vehicle
MAGR-2K-M	Miniature Airborne GPS Receiver 2000 – Modernized
MAPS	Mounted Assured PNT System Next Generation Capability
M-code	military code
MGUE	Military GPS User Equipment
MTA	middle tier of acquisition
NDAA	National Defense Authorization Act

OCS	Operational Control Segment
OCX	Next Generation Operational Control System
OUSD(A&S)	Office of the Under Secretary of Defense for Acquisition and Sustainment
PGK	Precision Guidance Kit
PNT	positioning, navigation, and timing

May 9, 2022

Congressional Committees

Decades after its inception, the Department of Defense (DOD) Global Positioning System (GPS) remains the principal source of positioning, navigation, and timing (PNT) information for the U.S. military and NATO partners. DOD has been working for more than 2 decades to modernize GPS to use a more jam-resistant, military-specific signal called military code (M-code), which is critical to maintaining the system's effectiveness in the face of adversary threats. The Air Force launched the first GPS satellite capable of broadcasting the M-code signal in 2005 and efforts to develop M-code user equipment are still underway. These efforts include the development of specific equipment, called M-code cards, which the military services will integrate into specialized GPS receivers for use in military aircraft, ships, vehicles, and other weapon systems. Together, these cards and receivers will be capable of receiving and using the M-code signals broadcast by the GPS satellites. In August 2021, day-to-day responsibility for modernizing and sustaining GPS transitioned from the Air Force to the Space Force's Space Systems Command. The Space Force was established in 2019 to conduct global space operations, and is organized within the Department of the Air Force.[1]

Section 1621 of the National Defense Authorization Act (NDAA) for fiscal year 2016 included a provision for GAO to report to the congressional defense committees on, among other things, the cost, schedule, and performance of the GPS acquisition programs until they reach initial operational capability.[2] The Senate Report accompanying the NDAA for Fiscal Year 2020 included a provision for GAO to examine the military services' determinations on M-code-capable user equipment needs for their weapon systems.[3] This report assesses (1) the Space Force's progress on the space, ground control, and user equipment segments of the GPS enterprise, including its management of risks; (2) the extent to which DOD and the services have identified and prioritized systems to field with M-code-capable equipment; and (3) the extent to which the

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[1]Section 952(b) (3)(4) of Pub. L. No. 116-92 (2019) (codified at 10 U.S.C. § 9081) established the U.S. Space Force as an armed force within the Department of the Air Force.

[2]Pub. L. No. 114-92, § 1621 (10 U.S.C. § 2281 note).

[3]S. Rep. No. 116-48, at 336 (2019).

services have planned for the procurement, installation, and fielding of M-code-capable user equipment onto designated priority weapon systems.

To conduct our work, we reviewed pertinent documentation, such as cost, schedule, performance, and risk reports, and conducted interviews with relevant officials from DOD, the Army, Navy, Marine Corps, Air Force, and Space Force. For additional details, see appendix I.

We conducted this performance audit from March 2021 to May 2022 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

GPS consists of three segments: space, ground control, and user equipment. The space segment consists of a constellation of orbiting satellites that continuously broadcast distinct signals and information about the time the satellites send the signals. The ground control segment commands and controls the satellites. The user segment is comprised of receivers used by the military in aircraft, ships, land vehicles, munitions, and handheld devices that derive positioning, navigation, and timing information from the satellite signals. Since 2000, the Air Force and Space Force have been pursuing a multibillion-dollar effort to modernize the three segments of GPS to provide new signals, enhance cybersecurity, and counter known and emerging threats.

GPS Modernization

Collectively, the ongoing GPS acquisition efforts aim to sustain the existing GPS capability and enhance the current GPS system by adding M-code GPS capability. M-code is a stronger, encrypted, military-specific GPS signal designed to meet military PNT information needs. M-code will help military users overcome attempts to block the GPS signal, known as jamming, by using a more powerful signal with a broader radio frequency range. It will also enhance protection against false GPS signals, known as spoofing, by encrypting the signal. This report will focus on the addition of M-code GPS capability. Figure 1 shows the GPS satellite, ground control,

and user equipment segments that function together as an operational system.

Figure 1: Global Positioning System Operational System
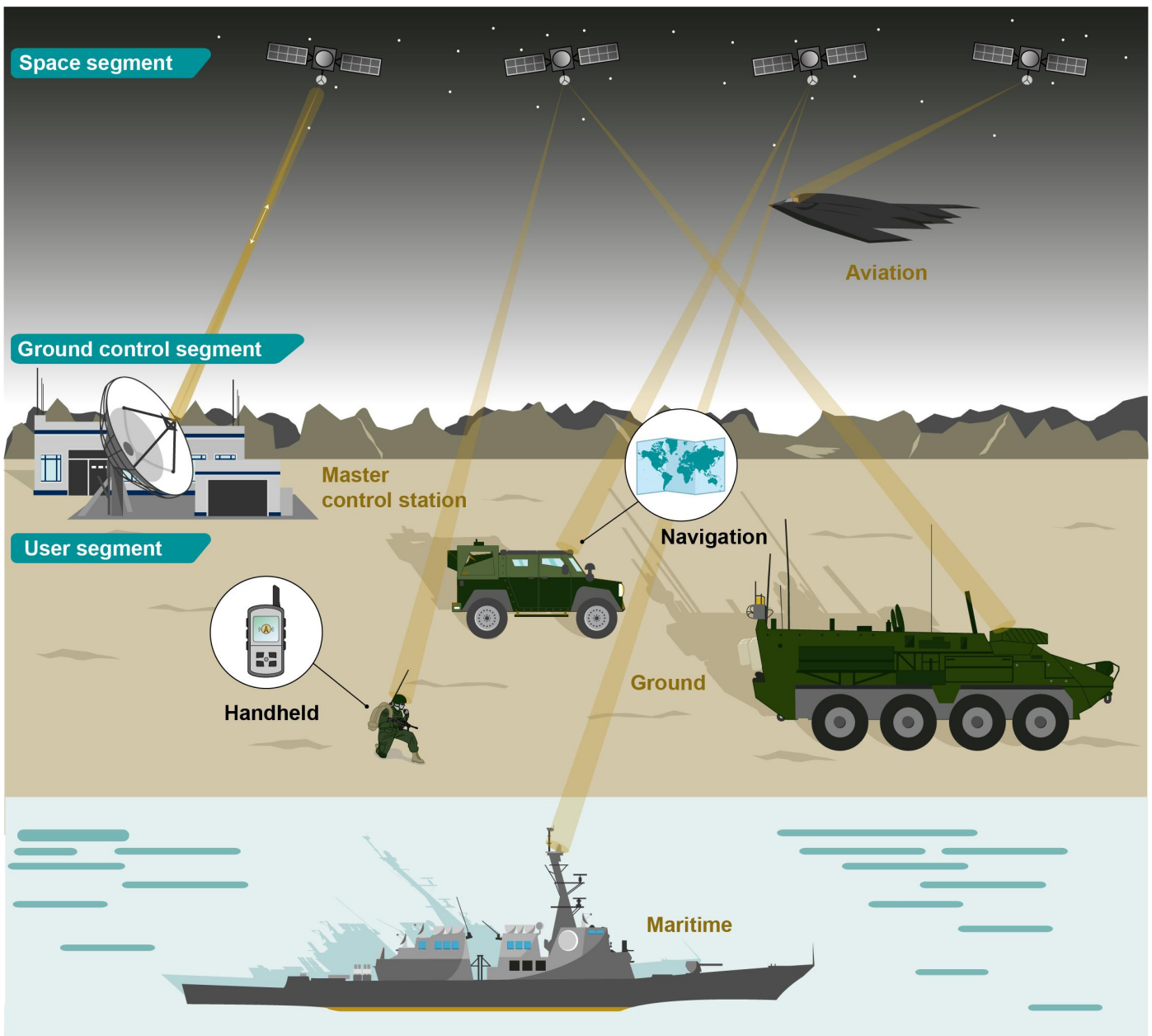
Source: GAO analysis and representation of Department of Defense documentation. | GAO-22-105086

M-code Space and Ground Segment Capability

Previous generations of satellites have been able to transmit the M-code signal since 2005, but the GPS ground control segment did not have the functionality to enable user access to M-code. Integrating the M-code capability into GPS requires launching new M-code-capable satellites, as well as developing a ground control system that can enable the launch and control of both existing and new, more powerful and capable satellites. This M-code integration effort comprises two major acquisition efforts: (1) the space segment with the GPS III and GPS III Follow-On (GPS IIIF) satellite programs, which will replace existing satellites that are near the end of their intended operational life; and (2) the ground segment with the GPS Next Generation Operational Control System (OCX) to control the satellites. See table 1 for a description of these segments.

Table 1: Current GPS Satellite and Ground Control Modernization Programs

Dollars in billions

Program	Description	Total Program Costs as of January 2022
GPS III / GPS III Follow-On (GPS IIIF)	**Space Segment.** GPS III satellites will supplement and eventually replace the current constellation of satellites, sustaining capabilities and providing new signals. The constellation currently consists of multiple generations of satellites. Lockheed Martin is the prime contractor for the first 10 GPS III satellites as well as up to 22 subsequent GPS IIIF satellites. As of June 2021, the Space Force accepted five GPS III satellites for operations.	**GPS III—$6.1** **GPS IIIF—$9.9**
Next Generation Operational Control System (OCX)	**Ground Control Segment**. OCX will replace the current ground control system, known as the Operational Control Segment (OCS). The OCX effort will include upgrades to the current GPS master control station as well as monitoring stations throughout the world. OCS lacks modern cybersecurity protections and the Air Force did not originally intend it to control or enable the modernized features of the two latest generations of GPS satellites now in orbit, including military code (M-code). The Air Force completed updates to OCS software in 2020, enabling operational control of GPS III satellites as well as specific M-code signals to allow for testing of M-code prior to the delivery of OCX. Raytheon Technologies, the prime contractor for OCX, is developing OCX in a series of blocks. Block 0—provides the launch and checkout system and supports initial testing of GPS III satellites. GPS III satellites cannot launch without OCX Block 0. It also provides modern cybersecurity capabilities, a key advancement in securing the system. The Air Force took possession of Block 0 in October 2017. Blocks 1 and 2—will provide command and control for previous generations of satellites and GPS III satellites, monitoring and control for both current and modernized signals, and full M-code broadcast capability. The planned delivery date for Blocks 1 and 2 is October 2022, with the system expected to begin operations in April 2023. Block 3F—will upgrade OCX with new capabilities to control and use the GPS IIIF space segment and Military GPS User Equipment Increment 2 capabilities. The Space Force awarded a development contract for OCX Block 3F to Raytheon in April 2021.	**OCX—$7**

Source: GAO analysis of Department of Defense data. | GAO-22-105086

Note: All dollar amounts are in fiscal year 2022 dollars.

GPS M-code User Equipment Segment

In order for warfighters to utilize the M-code signal transmitted by the space segment and controlled by the ground segment, the Army, Navy, Marine Corps, and Air Force will need to upgrade existing weapon systems with M-code-capable user equipment.[4] As we previously

[4]The U.S. Marine Corps is part of the Department of the Navy. 10 U.S.C. § 8041(a).

reported, DOD plans to add M-code-capable user equipment to approximately 700 different types of weapon systems such as aircraft, ground vehicles, ships, and other equipment.[5] The services will outfit systems with modernized, M-code-capable GPS receivers. Eventually, the total number of GPS receivers purchased by DOD could number close to 1 million, across these 700 types of weapons systems.

GPS user equipment consists of three key components—a microelectronic circuit chip, a card that uses the chip, and a receiver that provides the ability to use the card—and the development and manufacture of each is a key part of the overall modernization effort. One key element in GPS modernization has been the development of an application-specific integrated circuit (ASIC), a type of microelectronic component that enables user equipment to decode and process the GPS signals. The three contractors producing GPS receiver cards—Raytheon, BAE Systems, and L3Harris—then integrate the chip into a card that converts M-code and other GPS signals to PNT information. The services will then integrate each specialized M-code card into a receiver that provides an interface with the host weapon system, enabling display of PNT information to the user. See figure 2 for a simplified depiction of GPS user equipment integration for one system.

Figure 2: Global Positioning System User Equipment Integration

| ASIC chip | M-code card | M-code receiver | Weapon system |
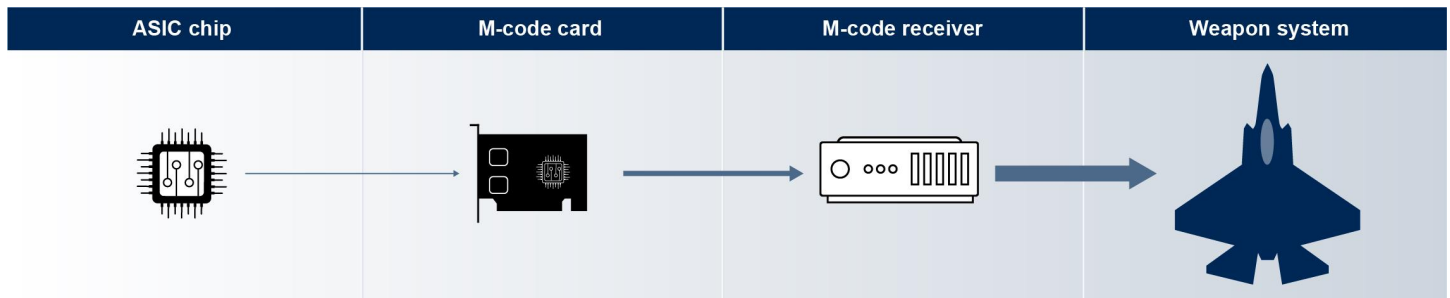
ASIC   Application-Specific Integrated Circuit
M-code   Military code
Source: GAO analysis and representation of Department of Defense documentation. | GAO-22-105086

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[5]GAO, *GPS Modernization: DOD Continuing to Develop New Jam-Resistant Capability, But Widespread Use Remains Years Away*, GAO-21-145 (Washington, D.C.: Jan. 19, 2021).

Military GPS User Equipment Increment 1

The Space Force's Military GPS User Equipment (MGUE) program is developing initial M-code-capable user equipment. In January 2017, DOD approved the MGUE Increment 1 program, the first of two increments, to begin development. Three different contractors—L3Harris, Raytheon, and BAE Systems—are developing Increment 1 M-code cards. Critical to the development of MGUE Increment 1 is the production of the ASIC chip. GlobalFoundries, the sole manufacturer of these chips, is in the process of phasing them out of production as more advanced technologies now dominate the commercial microelectronics market. M-code cards developed under the MGUE Increment 1 program, as well as derivative versions of these cards, all require the Increment 1 ASICs specially designed for them. There is no potential for an off-the-shelf replacement.

To ensure that the services have enough Increment 1 ASICs to meet DOD's M-code equipment integration and fielding needs through 2028, the Defense Logistics Agency (DLA) is conducting a bulk buy of nearly 1 million of these chips. Officials from the Office of the Under Secretary of Defense for Acquisition and Sustainment (OUSD(A&S)) said they obtained estimates from the services in late 2019 for the quantities of ASICs needed. DLA officials said they awarded contracts to Raytheon and BAE Systems in May 2021 for bulk orders of their ASICs from GlobalFoundries. The deadline for procurement of L3Harris's Increment 1 ASIC preceded the award date for the bulk buy, and the Army—as the primary customer for L3Harris's M-code cards—procured approximately 200,000 ASICs beyond those procured through the bulk buy.

The MGUE Increment 1 program is developing two card types—one for ground systems such as combat vehicles, which we refer to as the ground card, and one for the aviation and maritime systems for use on aircraft and ships, which we refer to as the aviation/maritime card. The program initially included five card development efforts through three contractors. The program office reported that L3Harris was awarded a contract to develop a ground card, while BAE and Raytheon were each awarded contracts to develop both ground and aviation/maritime cards.

Each of the contractors for the MGUE Increment 1 program are developing variants of these cards that we refer to as derivative cards. Derivative cards are expected to use the same ASIC as their Increment 1 parent cards, as well as much of the same software developed for the original cards. Derivative cards vary in size, technical capability, and

security architecture, and sometimes include design elements that meet the specific needs of a given receiver type.

The services expect to have options as each of the cards are developed. For each weapon system, when the services upgrade to M-code, they can select an Increment 1 card or a derivative card developed by one of the three contractors, or pursue additional development of a different card at their own expense.

The MGUE Increment 1 program was initially expected to be completed upon meeting four exit criteria for the first ground card—developed by L3Harris—and the first aviation/maritime card—developed by Raytheon—to achieve program milestones. One criterion for each card was operational testing on lead weapon systems selected by the Army, Air Force, Navy, and Marine Corps. DOD acquisition policy identifies operational test and evaluation as a key event in major capability acquisitions.[6]

The program has since changed these criteria. We reported last year that in August 2020 the Air Force revised the exit criteria to adapt to development delays, rising program costs, and changes in contractors' M-code card marketing strategies and production plans.[7] Those changes included:

- Requiring operational testing, with oversight by the Director, Operational Test and Evaluation (DOT&E), only for the two lead weapon systems testing the Raytheon aviation/maritime card. The Increment 1 program will test the Raytheon card on the Air Force's B-2 Spirit bomber and the Navy's DDG 51 Arleigh Burke class destroyer.

- Requiring a field user evaluation with no DOT&E oversight for weapon systems testing with the L3Harris ground card. This card will be the first to complete program milestones. DOT&E oversight will no longer be required because the contractor does not plan to produce the card in the current configuration. With the change in criteria, the Increment 1 program intended to conduct field user evaluations on the Army's Stryker and the Marine Corps' Joint Light Tactical Vehicle (JLTV). The Space Force and Army agreed in March 2021, however, that the JLTV

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

[7]GAO-21-145.

field user evaluation would meet the Army's test objectives for the Stryker.

Military GPS User Equipment Increment 2

The Air Force approved the acquisition strategy for MGUE Increment 2 in November 2018. The program's acquisition strategy is to pursue two middle tier of acquisition (MTA) rapid prototyping efforts.[8]

- The first MTA effort involves developing a more advanced Next-Generation ASIC paired with a more compact M-code card. Raytheon, BAE, and L3Harris are each developing an Increment 2 card. The program completed preliminary design reviews for each contractor's Next-Generation ASIC in 2021 and is working toward preliminary design reviews on the receiver card in mid-2022.

- The second MTA effort will develop a modernized handheld GPS receiver available for use by all of the military services, with development consisting of two phases. Phase one includes risk-reduction prototyping and phase two includes handheld receiver development. The first phase began in 2019 and Space Force officials expect the second to start in mid-2025.

M-code Receiver Development

The services are procuring or developing several different models of M-code-capable receivers for use with an Increment 1 card or a derivative card.[9] The services are tailoring these receivers to meet the varying needs of systems that operate in the ground, aviation, and maritime domains. In addition, the services are developing some receivers to

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[8]Section 804 of the National Defense Authorization Act for Fiscal Year 2016, Pub. L. No. 114-92 (2015) (10 U.S.C. § 2302 note) required DOD to issue guidance establishing two new streamlined acquisition pathways for DOD—rapid prototyping and rapid fielding—under the broader term middle tier of acquisitions. The objective of the rapid prototyping path is to field a prototype that can be demonstrated in an operational environment and provide for a residual operational capability within 5 years of the program start date. These acquisition pathways are distinct from the acquisition system for major defense acquisition programs in that they allow for programs to be exempted from certain acquisition and requirements processes normally followed for such acquisitions. For more information, see GAO, *DOD Acquisition Reform: Leadership Attention Needed to Effectively Implement Changes to Acquisition Oversight*, GAO-19-439 (Washington, D.C.: June 5, 2019).

[9]Some of these receivers (or the equipment housing them) have other capabilities besides processing GPS signals, such as providing timing signals.

process both M-code as well as PNT information derived from other sensors or equipment, which we refer to as multi-PNT receivers. We recently reported on development of alternate PNT systems and receivers that use information sources other than, or in addition to, signals from the GPS system.[10]

Receiver development efforts for weapon systems are dependent on the Space Force providing fully functional M-code cards in order to conduct developmental and operational testing. Additionally, the services are in the process of identifying, and in some cases conducting integration and testing on, the modernized receivers they will field on the hundreds of weapon systems the services will equip with modernized GPS reception capability. See figure 3 for a simplified depiction of entities involved with receiver development.

Figure 3: Global Positioning System User Equipment Integration and Receiver Development Entities
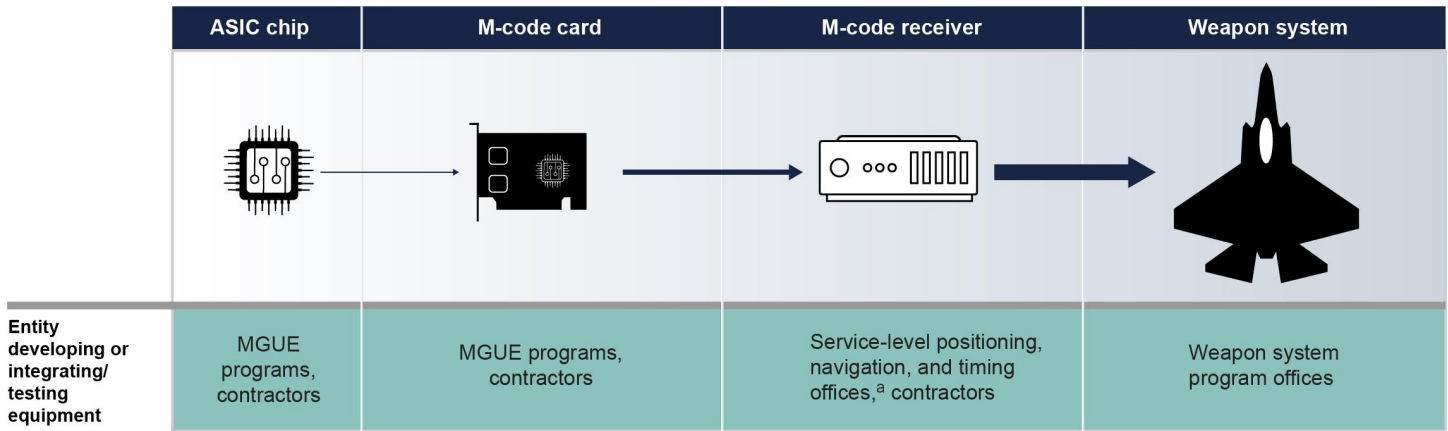
ASIC chip	M-code card	M-code receiver	Weapon system
MGUE programs, contractors	MGUE programs, contractors	Service-level positioning, navigation, and timing offices,[a] contractors	Weapon system program offices

Entity developing or integrating/ testing equipment

ASIC   Application-Specific Integrated Circuit
M-code   Military code
MGUE   Military GPS User Equipment

Source: GAO analysis and representation of Department of Defense documentation. | GAO-22-105086

[a]Includes offices such as: Air Force PNT Program Office, Navy Communications and GPS Navigation Program Office, Army Assured Airspace Access Systems, and Army Project Manager for Positioning, Navigation, and Timing.

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[10]GAO, *GPS Alternatives: DOD is Developing Navigation Systems But Is Not Measuring Overall Progress*, GAO-22-104609SU (Washington, D.C.: April 6, 2022).

PNT Oversight Council

DOD established the PNT Oversight Council in 2016 in response to a 2015 statute.[11] The statute required the PNT Oversight Council to be responsible for oversight of DOD's PNT enterprise and pointed to several specific responsibilities including vulnerability identification and mitigation, oversight of performance, and resource prioritization. The PNT Oversight Council is comprised of three levels of leadership: the chairs, which are represented by the Under Secretary of Defense for Research and Engineering, the Under Secretary of Defense for Acquisition and Sustainment, and the Vice Chairman of the Joint Chiefs of Staff; the Executive Management Board, chaired by DOD's Chief Information Officer; and six working groups focusing on different aspects of PNT.

PNT Data Repository

The office of the DOD Chief Information Officer (CIO) established a database to track M-code development and integration across the department in 2015, known as the PNT Data Repository. According to agency officials, the CIO developed the repository to track progress implementing M-code and to function as an oversight tool.[12]

The PNT Oversight Council uses the database for tracking progress toward M-code integration and fielding. The database also provides an inventory of systems that use GPS and plans for transitioning to M-code. Information from the database supports various reports to congressional defense committees, such as the annual report required through 2021 by Section 1610 of the National Defense Authorization Act for Fiscal Year 2019. OUSD(A&S) is using the PNT Data Repository to develop a policy

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[11]Pub. L. No. 114-92, § 1603(a) (2015), (codified, as amended, at 10 U.S.C. § 2279b). As originally enacted, the statute established two co-chairs: the Under Secretary of Defense for Acquisition, Technology, and Logistics, and the Vice Chairman of the Joint Chiefs of Staff. In connection with the reorganization of the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, Congress amended the statute in 2019 to establish three co-chairs, as described above. See National Defense Authorization Act for Fiscal Year 2020, Pub. L. No. 116-92, § 902(31), (2019) (codified as amended at 10 U.S.C. § 2279b).

[12]See generally DOD Instruction No. 4650.06, *Positioning, Navigation, and Timing Management* (July 30, 2020, incorporating change 1 May 7, 2021).

for issuing waivers to a law that requires GPS user equipment purchased after fiscal year 2017 to be capable of receiving M-code.[13]

As of January 2022, DOD is operating under a waiver that applies to all systems that OUSD(A&S) issued to cover all GPS user equipment purchases until March 31, 2022. Officials said, however, that they plan to use the fielding dates in the database to identify which specific programs will require waivers in the future, as M-code equipment becomes available for fielding.

While DOD CIO is responsible for maintaining the PNT Data Repository, the military services are responsible for inputting data and ensuring that their data are accurate. Various service-level offices are responsible for entering data into the database. For example, service officials told us that the Army's Assured Positioning, Navigation, and Timing/Space Cross Functional Team collects the data on Army systems and the Navy's office of the Assistant Secretary of the Navy for Research, Development, and Acquisition collects the data on Navy systems. CIO officials said they request updates to the database once per year.

Space Force Has Made Progress, and Officials Are Addressing Remaining Risks at an Enterprise Level

GPS Enterprise Has Made Progress toward Delivery of M-code Capability, but Risks Remain

Programs within the Space Force's GPS enterprise achieved milestones and other accomplishments in the past year, but each segment faces significant risks. The space segment is nearing full operational capability for M-Code broadcast, and Space Force officials stated that the ground control segment is expected to attain full M-code capability in early 2023.

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[13]Ike Skelton National Defense Authorization Act for Fiscal Year 2011, Pub. L. No. 111-383, § 913. This act provides that none of the funds authorized to be appropriated or otherwise made available under the act or any other act for DOD may be obligated or expended to purchase GPS user equipment after fiscal year 2017 unless the equipment is capable of receiving M-code. The Secretary of Defense may waive this limitation under certain circumstances or certain exceptions may apply. Concurrent with M-code card development delays, DOD issued waivers for this requirement for the hundreds of types of weapon systems that will eventually integrate M-code cards.

Despite this progress, risks remain in all three segments. The most significant risks remain in the MGUE Increment 1 program. If these risks are realized, they will further delay the services' fielding of aviation and maritime user equipment and widespread operational use of M-code, which already remains years beyond the space and ground segment milestones. Figure 4 shows key delivery dates for GPS enterprise capability.

Figure 4: Timeline Showing Full Operational Capability for M-code Satellites, OCX Initial Operational Capability, MGUE Test Events

	2021	2022	2023	2024	2025	2026

GPS Satellite Constellation — Full operational capability for M-code broadcast

OCX Blocks 1/2 — Initial capability

MGUE Increment 1 Ground Card — Field test

MGUE Increment 1 Aviation/Maritime Card — Maritime operational test

MGUE Increment 2 Card — Delivery

MGUE Increment 2 Handheld Receiver — Field test
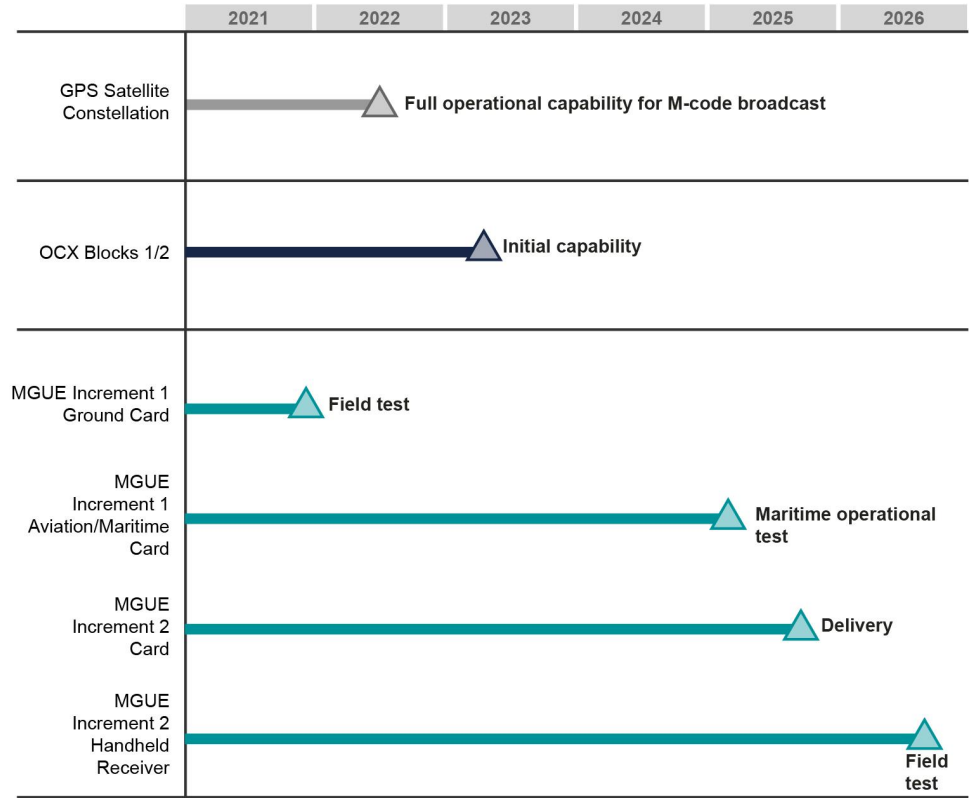
OCX Next Generation Operational Control System
MGUE Military GPS User Equipment

Space segment
Ground control segment
User equipment

Source: GAO analysis of Department of Defense information. | GAO-22-105086

Space Segment

The Space Force has progressed in efforts to replenish the GPS constellation with new GPS III satellites. In June 2021, the Space Force launched the fifth GPS III satellite. This satellite is the 24th M-Code-capable satellite within the GPS constellation and, according to program officials, is projected to complete extended testing and be made operational in spring 2022. Once that occurs, the space segment will fulfil the minimum requirement for full operational capability for M-code signal broadcast. In 2021, the Space Force accepted three additional GPS III satellites from Lockheed Martin, the contractor for this effort. These three satellites will launch over the 2023-25 time frame.

Despite this progress, the Space Force has encountered technical challenges in developing the navigation payload for the follow-on GPS IIIF satellites, creating risk for delays in satellite delivery. The GPS IIIF satellite program encountered technical challenges building six developmental versions of the mission data unit that provides GPS signals. To address one of the unit's technical issues, the program had to redesign an integrated circuit for a key subcomponent. As a result of the technical challenges, from November 2020 to October 2021, GPS IIIF officials said the program experienced delays averaging 11 months for deliveries of the six developmental mission data units. The program responded to these technical challenges by restructuring test plans in order to mitigate potential schedule delays to delivery of the first GPS IIIF satellite, currently scheduled for February 2026.

Ground Control Segment

The Space Force's Next Generation Operational Control System (OCX) program made progress since our last report in 2021 in testing and integrating its mission software. During 2021, the program completed qualification testing of mission software on its original server hardware. It also began integrating this software onto new server hardware in preparation for qualification testing per the March 2020 contract modification to replace the original server hardware.[14] The transition to

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[14]As originally configured, OCX was to operate on IBM server hardware; however, IBM sold the server product line used by the program to Lenovo, a Chinese corporation, creating a cybersecurity risk. Consequently, in March 2020, the OCX program modified an existing contract with Raytheon to replace IBM hardware. For more information, see GAO, *Weapon Systems Annual Assessment: Updated Program Oversight Approach Needed,* GAO-21-222 (Washington, D.C.: June 8, 2021).

new server hardware is the result of obsolescence and cybersecurity concerns with the original hardware.

The OCX program continued, however, to experience schedule delays and cost growth. Since January 2020, the program delayed delivery of the system by 16 months, from June 2021 to October 2022, with cost growth totaling at least $379 million. This includes a 10-month delay resulting from the replacement of the original server hardware. Additionally, the program experienced 2 months of delays as a result of the COVID-19 pandemic. This delayed software development efforts as well as upgrades to monitoring station installations around the world. The program completed installation of the upgrades to the 17 monitoring stations in July 2021—12 months later than the program's estimate prior to the pandemic—although these delays did not directly affect system delivery dates.

The OCX program continues to face risk to its schedule because the testing that remains could take longer than expected and the schedule contains only 1 month of margin to the date by which OCX is required to be ready to transition to operations. Before the planned October 2022 contractor delivery of OCX, the program must complete software qualification testing on the new hardware and complete subsequent acceptance testing. Discovery of deficiencies during this period could slow such testing and thereby pose risk to the planned delivery date. Following the contractor delivery, the program must complete government-led testing of the integrated system before program officials can declare it ready for operations. We previously reported that the 7 months planned for this testing under a prior schedule might be insufficient.[15] As of January 2022, the program projects that OCX will be ready for operations in March 2023, which means there will be less than 6 months in which to conduct the integrated system testing that follows contractor delivery of OCX. Figure 5 details the remaining events in the OCX development schedule.

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[15]GAO, *Global Positioning System: Updated Schedule Assessment Could Help Decision Makers Address Likely Delays Related to New Ground Control System*, GAO-19-250 (Washington, D.C.: May 21, 2019).

Figure 5: Steps Required to Complete the Full Schedule for the OCX
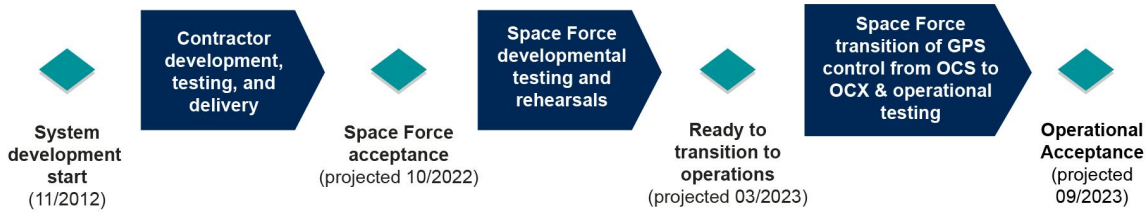
OCS   Operational Control Segment
OCX   Next Generation Operational Control System

Source: GAO analysis of Department of Defense information. | GAO-22-105086

We also reported in June 2021 that additional delays to the current OCX efforts could affect the schedule of follow-on efforts required for the launch, checkout testing, and operation of GPS IIIF satellites.[16] The Space Force scheduled development of the OCX capability required to launch and operate GPS IIIF satellites to begin in March 2022. As the GPS IIIF program anticipates acceptance of the first GPS IIIF satellite in early 2026, program officials structured the delivery of the OCX capabilities required to operate these satellites in three phases. The first of these will be the launch and checkout system, for which program officials project contractor delivery in late 2023 to support GPS IIIF launch preparation activities. The program projects contractor delivery of all required capabilities by August 2025.

User Equipment Segment

The MGUE Increment 1 program completed testing of the ground card in 2021 and made progress in identifying and addressing deficiencies in the aviation/maritime card.

- In September 2021, the Marine Corps completed a field user evaluation of the MGUE Increment 1 ground card on the JLTV. The Marine Corps and Space Systems Command are in the process of adjudicating the test results. Once this process is complete, results of the field user evaluation will inform the services' fielding of ground cards.

- The Increment 1 program also made progress with aviation/maritime card development. Specifically, the program identified solutions for more than half of the previously identified aviation/maritime card

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[16]GAO-21-222.

deficiencies, and, as of November 2021, verified 84 percent of the card's technical requirements. Raytheon, the contractor responsible for the card, delivered updated software in November 2021. Program officials expect this updated software to enable verification of all remaining technical requirements, as well as preliminary integration on the B-2 and DDG 51 class.

Despite progress in addressing known deficiencies with the aviation/maritime card, the program now expects final testing on the card to be completed more than 3 years later than initially planned. Aviation/maritime card testing will not be completed until the end of full operational testing and evaluation on the B-2 and the DDG 51 class systems. Early in development, the Increment 1 program projected completion of this testing in April 2021, but now expects it to be completed by February 2025. This is due to technical challenges that resulted in a significantly revised schedule and $164 million in additional costs.

The emergence of new technical challenges in the aviation/maritime card in 2021 placed additional risk on the MGUE Increment 1 schedule and on the eventual fielding of the aviation/maritime card across the services. For instance, the program identified an issue with the GPS receivers for the B-2 and DDG 51 class, which cannot yet decode the timing signal from the M-code cards. Program officials are prototyping various solutions that include adjustments to the card as well as integration workarounds. Delays working through this issue could further postpone completion of development and final testing on the aviation/maritime card.

As previously noted, aviation and maritime receiver development efforts are reliant on fully functional M-code cards for development and testing. Therefore, even without further Increment 1 delays, fielding of M-code-capable user equipment on aviation and maritime systems in sufficient quantities to enable widespread operational use remains years away. This expected delay in availability of widespread use is despite the Space Force's expected attainment of full M-code operational capability for the space segment this year and projected attainment of full M-code ground control in March 2023.

The MGUE Increment 2 program completed a key milestone in development of the Next-Generation ASIC in mid-2021. Specifically, Increment 2 contractors completed preliminary design reviews for the Next-Generation ASIC. Program officials reported that each contractor had difficulties with power and thermal requirements but noted that these

challenges are normal for an effort at this stage. In fact, the power requirement has been a known significant risk since before program initiation. They also indicated that, once the ASIC design is released to the manufacturer, any further delays would directly affect the overall Increment 2 M-code card development schedule.

The Increment 2 program also completed significant reviews for overall M-code card designs in 2021, but experienced some early delays and schedule risks. Specifically, Increment 2 contractors completed system requirements and functional reviews for their M-code cards and are working toward preliminary design reviews expected in mid-2022. Program officials said they initially planned to conduct those reviews in late 2021 but postponed them by 6 to 9 months, depending on the contractor, because of technical requirements added by the Space Force. Officials said that the service added those requirements to the program baseline before significant work was completed, meaning that contractors avoided the potential for significant rework. The contractors, however, will now have to absorb the near-term delays into their overall program, creating additional risk of schedule slippage.

Space Force Is Addressing Risks for M-code Implementation at the Enterprise Level

The Space Force's Space Systems Command is addressing risk for M-code delivery at an enterprise level. In doing so, the command is employing an integrated approach that takes into account the GPS acquisition portfolio as a whole, rather than addressing risk solely at the level of the individual acquisition programs for the space, ground control, and user equipment segments. This enterprise-level approach to risk acknowledges the need for coordination across programs to deliver M-code capability to the warfighter. Space Systems Command addresses risk to the GPS enterprise by using

- risk management processes,
- standardized metrics to assess program progress, and
- organizational structures that facilitate coordination across GPS acquisition programs.

Risk Management

Space Systems Command established a risk management plan that establishes the processes and procedures required to achieve the risk management objectives of the GPS enterprise. The plan, approved in February 2018, defines risk tolerance, risk processes, and risk responses.

According to the GPS risk management plan, risk boards and working groups are responsible for using the decision-making processes outlined in the plan to manage GPS risks. The plan states that these boards are to meet regularly to discuss and review risks, assess risk severity, and make decisions in order to address risks. This can include the re-allocation of resources. The boards are organized at both the GPS enterprise level and at the program level.

As a part of risk management, the GPS enterprise also maintains a risk register that identifies enterprise-level risks and plans for mitigating them. As of January 2022, there were 13 risks identified as enterprise-level, while the remainder were categorized as program-level (e.g., for OCX). Among the enterprise-level risks was one that pertains to M-code availability for use. The mitigation plan for this risk entails various steps and identifies specific entities responsible for taking them. These entities include a range of offices, from the GPS acquisition program offices, such as GPS III or MGUE, to offices overseeing testing, such as the Air Force Operational Test and Evaluation Center. In addition, the GPS acquisition programs each maintain program-level risk registers. Program officials assign program-level risks to an owner who is charged with overseeing risk mitigation efforts. Occasionally, however, there are mitigation steps assigned to owners outside of the program office, such as the Test and Evaluation office.

Measuring Progress

Space Systems Command measures progress of the GPS enterprise against standard DOD metrics for the individual acquisition programs. Specifically, each GPS acquisition program that has entered the engineering and manufacturing development phase has cost, schedule, and performance parameters approved by either a service-level or DOD-

level Milestone Decision Authority.[17] Oversight authorities—such as the Program Executive Officer that oversees Space Systems Command acquisitions—and independent test organizations measure each GPS acquisition program against (1) objective values for those parameters, which represent goals in terms of the ultimate capability that the user desires and expects; and (2) threshold values, which represent the limit of what is acceptable.

Space Systems Command maintains a detailed GPS Enterprise Master Schedule to track how the GPS acquisition programs are progressing toward delivery of capability. The command also produces a more simplified GPS Enterprise Roadmap, which tracks and highlights major milestones and correlates them to program-level activities. According to Space Systems Command officials, the GPS Enterprise Roadmap provides the ability to identify schedule risk through the accessible, integrated view that it provides. In updating the program-level dates on the GPS Enterprise Roadmap, Space Systems Command can track any interdependencies that could affect the anticipated deliveries of GPS capabilities. For example, M-code PNT initial operational capability depends on such factors as OCX completing an operational assessment and the MGUE Increment 1 program completing final testing on its lead platforms.

Enterprise Coordination Structures

The Space Systems Command also established structures aimed at facilitating communication across programs and cooperation within the GPS enterprise. For example, the command established a Positioning, Navigation, and Timing Mission Integration Board of Directors to facilitate communication between the GPS acquisition programs on GPS enterprise integration issues. The PNT Capability Area Integrator, an office separate from the acquisition programs, chairs this board, according to Space Systems Command officials. The board also includes

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[17]The Milestone Decision Authority for the GPS III, GPS IIIF, and MGUE Increment 1 programs is the Assistant Secretary of the Air Force for Acquisition, Technology & Logistics. The Milestone Decision Authority for the OCX program is the Under Secretary of Defense for Acquisition and Sustainment. The Program Executive Officer for Space Production is the Milestone Decision Authority for the OCX Block 3F program, which, as of February 2022, had not yet entered the engineering and manufacturing development phase. As a middle tier of acquisition program, MGUE Increment 2 does not have a Milestone Decision Authority or an acquisition program baseline, but the program does have Service Acquisition Executive approved cost and schedule guardrails within which the program is expected to execute.

the chiefs of the divisions in charge of the GPS acquisition programs, such as the office that oversees the GPS III and GPS IIIF programs and the User Equipment office that oversees the MGUE Increments 1 and 2 programs.

While the acquisition programs retain authority over program execution at the direction of the Program Executive Officer, the Board of Directors provides a forum for GPS mission integration and coordination activities. The PNT Mission Integration Board of Directors' activities include maintaining a list of priorities for the GPS enterprise. Among these priorities are planning efforts for upcoming events, such as the launch of the sixth GPS III satellite and developmental testing of OCX prior to its planned transition to operational use. Other priority items focus on events further in future, such as GPS IIIF launch preparation.

The PNT Mission Integration Board of Directors also chartered a number of GPS-specific PNT Enterprise Capability Integrated Product Teams (IPT), which conduct cross-programmatic planning and cooperation toward delivering specific GPS capabilities. The board established the first such capability IPT in 2017 to facilitate the launch of the first GPS III satellite, according to Space Systems Command officials. The officials further indicated that, because the PNT Mission Integration Board of Directors considered the IPT successful in its mission, the board members initiated additional IPTs focused on other GPS capability objectives. As of January 2022, there are eight IPTs, with such capability objectives as advancing the future GPS IIIF satellite operation and making military PNT information usable in contested (e.g., jamming) environments.

DOD and the Services Have Begun to Identify Systems to Field with M-code, but Incomplete Data Hinder Efforts

DOD Recently Identified Weapon System Priorities for M-code Modernization Based on Future Operational Challenges
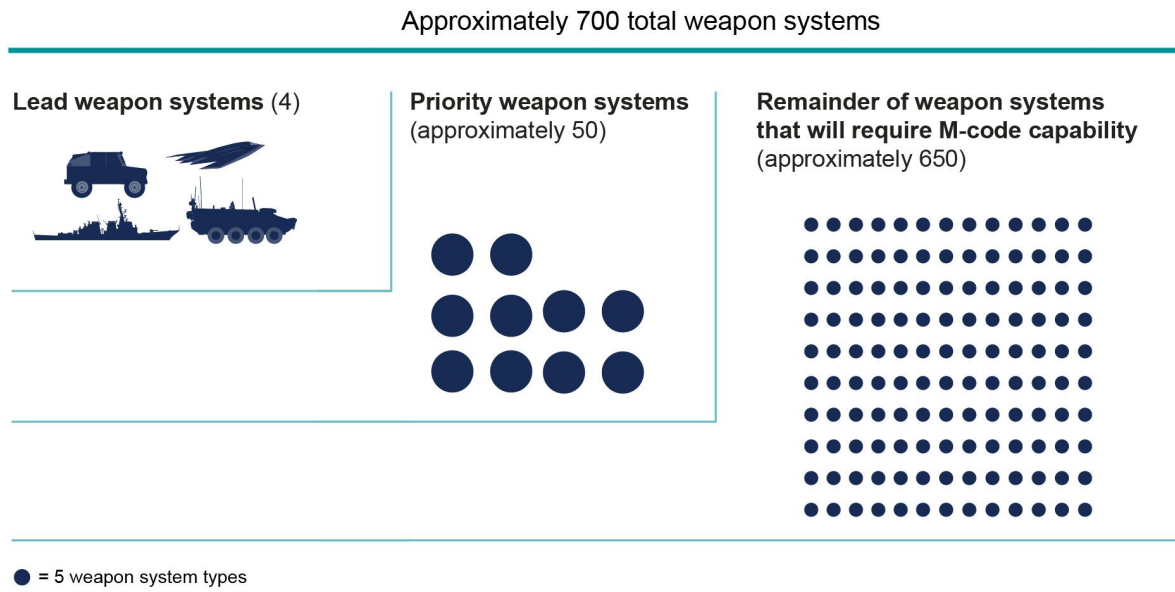
DOD identified priority weapon systems for M-code modernization based on anticipated operational challenges that could emerge in the near future. DOD developed an operational scenario to prepare for these

future challenges. The details of this scenario are classified. DOD plans to modernize weapon systems that are critical to this scenario over other less-critical systems.

Currently, there are more than 50 priority weapon systems. The largest numbers of priority weapon systems are in munitions and aviation systems. The Navy has the highest number of systems, followed by the Army. These priorities are distinct from the four lead systems chosen for MGUE Increment 1 developmental testing, and are a small subset of about 700 systems that will require GPS.

Priorities for M-code modernization take into account the needs of the specific classified operational scenario as well as the expected life spans of the weapon systems involved. Weapon systems that are expected to no longer be in use around or before 2030 are not priority weapon systems. With delays to Increment 1, some weapon systems are nearing the end of their life spans before M-code equipment is available, making it necessary to update priorities periodically. See figure 6 for a graphical representation of the different sets of systems slated as priorities for M-code modernization.

Figure 6: Notional Representation of Services' Lead, Priority, and Remaining Weapon Systems for Fielding with M-code

Approximately 700 total weapon systems

Lead weapon systems (4)

Priority weapon systems (approximately 50)

Remainder of weapon systems that will require M-code capability (approximately 650)

● = 5 weapon system types

Source: GAO representation of Department of Defense information. | GAO-22-105086

The process for developing the list of priority weapon systems has evolved over time. U.S. Strategic Command first developed a classified list of priority weapon systems for M-code integration based on DOD's operational scenario in 2014. U.S. Strategic Command coordinates information on specific capabilities in support of combatant commanders, among other functions. The PNT Oversight Council, based on service and combatant command inputs, updated the priority list in July 2020. The PNT Oversight Council also formalized a process in October 2020, led by U.S. Space Command, to update this list every 2 years. These updates include input from all of the combatant commands, with the most recent update occurring in January 2022.

As part of the identification of priority systems, the services provided input on their requirements and available resources to counter threats. For example, officials from one service said they conducted their own analysis of forces that required modernization. This included a determination of which units would deploy first into areas where GPS signals might be jammed or spoofed, and which systems would require M-code to counter adversary threats. According to officials from another service, the service ranked its systems into tiers of M-code integration need to identify priority goals.

Incomplete Information in DOD's GPS Modernization Database Hinders Oversight

We found that the information in the PNT Data Repository for tracking M-code modernization is incomplete, including for priority weapon systems, and that it is of questionable quality or accuracy. The database includes fields such as the types and numbers of GPS receivers various systems will use; projected budget requests by fiscal year; and projected dates for procurement, integration, and fielding. Many fields in the database are blank, however, such as those for projected budget needs. According to our review of selected fields in the database, as of December 2021, nearly all priority weapon systems have at least some blank budget information, 40 percent do not have information on the type of receiver needed, and 25 percent do not have integration dates. Additionally, OUSD(A&S) officials indicated that the information in the database is not yet of sufficient quality to use as a basis for developing M-code waiver policy, and does not provide an accurate picture of M-code modernization progress.

According to CIO and service officials, the primary cause of the incomplete data in the database is delays in the MGUE Increment 1 program. Delays in the development of M-code cards, and the aviation/maritime card in particular, created uncertainty as to when M-code receivers would be available for the services to consider. Consequently, service officials said they have not been able to finalize schedule and budget information and provide this information to the CIO. For example, Navy officials said that while they do designate funding for M-code integration, continued delays to Increment 1 mean budget information is no longer accurate and the program cannot execute to it, as they are unable to procure the cards and receivers. As the Increment 1 cards become available, the services expect to develop more accurate schedules and budgets. This, in turn, should help to complete the data requests.

Apart from MGUE Increment 1 delays, concerns regarding the completeness and quality or accuracy of information in the database stem from the lack of formal and comprehensive data validation. CIO officials said they do not formally conduct checks for accuracy on the data but conduct informal spot checks with assistance from OUSD(A&S). For example, they check to see if numeric fields contain numbers. CIO officials stated that they contact the services if they find issues with the data. Service officials told us that they also conduct some checks on their data before submission but, at the time of our review, none of the offices responsible for submitting these data had a formal data validation process. Specifically, the Army, Navy, and Air Force PNT offices or cross-functional teams look for completeness and inconsistencies, but do not employ formalized processes to audit the accuracy of the data.

The CIO developed the database to assist with monitoring DOD's progress modernizing PNT across the services. DOD policy for PNT management directs the CIO to conduct an annual survey of the services to collect PNT capability information in order to monitor modernization progress.[18] CIO officials said they consider the annual data request for the PNT Data Repository, which it uses to track progress implementing M-code and as an oversight tool, to be that annual survey. The policy also directs the services to provide information for the CIO's annual survey. According to *Standards for Internal Control in the Federal Government*,

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[18]DOD Instruction No. 4650.06, *Positioning, Navigation, and Timing Management* (July 30, 2020, change 1 effective May 7, 2021).

management organizations—in this case the CIO and the services—should collect and use quality information, and design and implement control activities to achieve organizational goals.[19]

Incomplete and inaccurate data hinder the ability of DOD and congressional defense committees to track the progress of these PNT modernization efforts. If not addressed, these issues would also hinder the process to determine which programs should receive M-code waivers in the future, as OUSD(A&S) would be unable to determine individual weapon system time frames for fielding M-code. As previously noted, the database also supports reports to congressional defense committees, including the PNT Oversight Council Annual Report. Thus, the issues hinder the committees' ability to track the progress of M-code and support DOD decision-making.

The office of the CIO has taken positive steps toward improving data quality. Among the recent changes made to the database:

- CIO officials said they added a field they use to designate priority weapon systems in summer 2021.

- CIO officials told us they review the data for completeness when they receive updates from the services, and contact the services about discrepancies.

- CIO and OUSD(A&S) asked the services to complete more targeted data input tasks, beginning in 2021. The offices focused these data requests on priority weapon systems.[20]

- In August 2021, CIO officials also made more data fields within the database mandatory, meaning the services must fill out these fields in order to save edits to the database. These new mandatory fields include a field for the common name of the weapon system and a field that corresponds to budget prioritization, among others. CIO does not intend to make fields regarding budget needs mandatory, stating that

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[19]GAO, *Standards for Internal Control in the Federal Government,* GAO-14-704G (Washington, D.C.: September 2014).

[20]In March 2021, OUSD(A&S) directed the services to update their data with a focus on gathering data on priority weapon systems to assist with the next round of waiver determinations. In addition, CIO initiated a data request in October 2021 with a deadline of January 2022, focusing on priority weapon systems and corresponding funding information. CIO officials said they would work to validate the data after the deadline.

would make it difficult for the services to update their data in an accurate manner as budget requests can change.

While the CIO has taken positive steps, these steps do not address all of the issues with the database as it lacks controls, such as formal written procedures, for ensuring data are validated for accuracy on a recurring basis. Both the CIO and the services have responsibility for ensuring the data quality is sufficient. As Increment 1 cards become available, the information needed for the database will be more stable and the services should be able to provide data that are more complete.

Due to Delays, the Services Have Only Recently Taken Steps toward Fielding M-code-Capable Systems

In order to field M-code capability in enough systems to provide adequate capability to the warfighter, the Army, Navy, Marine Corps, and Air Force must first develop user equipment specific to their weapon systems, test those systems in an operational environment, and integrate sufficient quantities of them with fielded systems. Delays to the completion of the MGUE Increment 1 ground and aviation/maritime cards have hindered the services' efforts to do so.

M-code Card Delays Continue to Hinder the Services' Development of M-code-Capable User Equipment

The delays in developing MGUE Increment 1 cards have hindered the services' efforts to plan for and develop M-code-capable user equipment. As previously noted, we consider M-code-capable user equipment to include ASICs, the M-code cards they integrate with, and the M-code receiver devices that process the M-code signal for the host weapon systems. Delays to M-code cards have:

- contributed to uncertainty about the adequacy of the bulk purchase of Increment 1 ASICs,

- led the Army to initiate development of M-code user equipment for ground vehicles and other applications that utilizes a derivative ground card, and

- hindered development of M-code receivers for aircraft.

ASIC Bulk Purchases

Delays in developing MGUE Increment 1 cards contributed to uncertainty about whether the bulk purchases of Increment 1 ASICs will be adequate to support the services. As previously noted, to address GlobalFoundries' plan to phase out production of all Increment 1 ASICs, DOD is planning to procure nearly 1 million ASICs through DLA's bulk purchase, and the Army separately procured approximately 200,000 ASICs. The bulk purchase of Increment 1 ASICs was intended to meet DOD's needs until 2028 or until the Increment 2 ASICs are available for integration with M-code cards. However, delays to the completion of initial M-code cards restricted the services' ability to plan for M-code integration and, as a result, restricted the ability of the services to estimate how many M-code cards they might need in the future before the bulk purchase was made. For example, the services did not select M-code receivers for some weapon systems prior to submitting estimates of the number of ASICs needed for the bulk purchase. As a result, the bulk purchase may not be sufficient to meet anticipated need.

There are differing views on whether the number of ASICs purchased will be sufficient. An OSD program evaluation official said service estimates for the number of ASICs needed on some weapon systems were incomplete, meaning that service estimates of the number of ASICs needed may be too low. Conversely, the official said estimates for other systems are likely higher than needed. Despite these views, Army officials said they are confident the estimates they provided to inform the bulk buy accurately reflect the Army's MGUE Increment 1 ASIC needs. Even if there are enough ASICs overall, it is not clear they will have enough for all the systems. For example, it is not clear that ASICs will be compatible across systems, meaning that it may not be as simple as swapping cards from, for example, a munition to an aircraft.

Development of Derivative User Equipment for Ground Vehicles

The Army is developing a number of different M-code receivers for ground vehicles, soldiers, and munitions. All of these receivers utilize derivative cards.

As we reported in January 2021, due in part to delays developing the MGUE Increment 1 ground card, Army officials said they decided to procure a primary M-code receiver for their ground vehicles that does not

use the Increment 1 card being developed by the MGUE program.[21] The Army reported selecting Collins Aerospace to provide the Mounted Assured PNT System Next Generation Capability (MAPS) in October 2020. This system will use a derivative of BAE's Increment 1 M-code card and will be a multi-PNT receiver. The Army was able to more quickly develop this derivative card, and by extension MAPS, because it was outside of the formal Increment 1 program. According to an Army official, in September 2021, the Army completed a successful operational test of MAPS. The Army plans an initial production decision for MAPS receivers in early 2022, with fielding to continue for several years. The Marine Corps has not yet selected a receiver to field on ground vehicles, but officials said they are considering MAPS.

Similarly, the Army reported selecting two contractors, Integrated Solutions for Systems Inc., and TRX Systems, to provide the Dismounted Assured PNT System (DAPS) multi-PNT receiver to units in support of an urgent capability need. Both versions of DAPS use the same BAE derivative card used in MAPS. An Army official said the DAPS program completed an operational assessment in October 2021 and the program selected TRX as the best value solution for future DAPS procurements. The official said they will consider the MGUE Increment 2 card for a future version of DAPS if it is ready in time for development and meets size, weight, and power requirements.
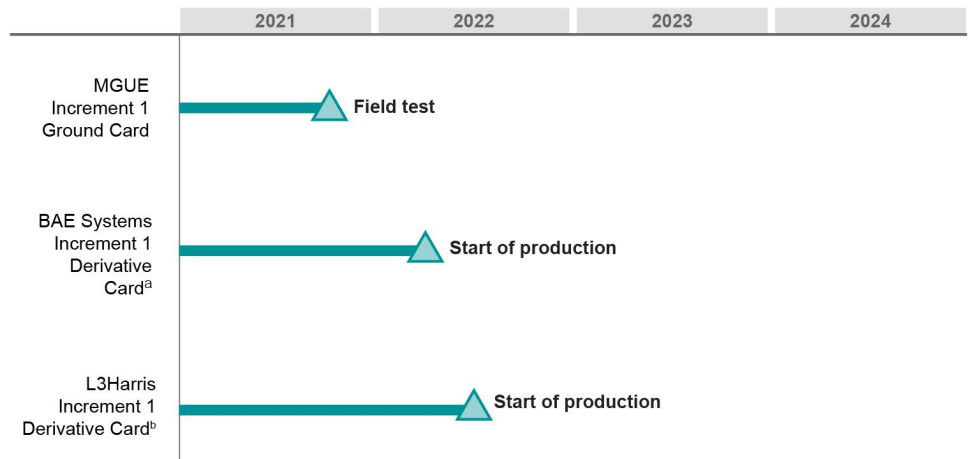
The Army is also incorporating derivative cards into various munitions. For example, as we reported in January 2021, the Army is employing an L3Harris derivative card in its Precision Guidance Kit (PGK).[22] As of October 2021, the Army expected to complete developmental testing of the M-code-equipped PGK at the end of fiscal year 2022. Army officials said the service is planning to use various BAE derivative cards to provide M-code capability for other munitions and launchers. See figure 7 for a timeline of selected ground card development efforts.

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[21]GAO-21-145.

[22]GAO-21-145.

Figure 7: Ground Card Development Efforts

	2021	2022	2023	2024

MGUE Increment 1 Ground Card — Field test

BAE Systems Increment 1 Derivative Card[a] — Start of production

L3Harris Increment 1 Derivative Card[b] — Start of production

MGUE Military GPS User Equipment

User equipment

Source: GAO analysis of Department of Defense information. | GAO-22-105086

[a]The BAE Systems derivative card will be integrated into the Mounted Assured PNT System and the Dismounted Assured PNT System.

[b]The L3Harris derivative card will be integrated into the M-code equipped Precision Guidance Kit.

## Aviation and Maritime M-code Receiver Development

Delays in development of the MGUE Increment 1 aviation/maritime cards have hindered, and continue to pose risk for, Air Force efforts to develop aviation receivers. In January 2021, we reported that the Air Force expected the Miniature Airborne GPS Receiver 2000 – Modernized (MAGR-2K-M) receiver program to fall behind schedule due to Increment 1 aviation/maritime card delays.[23] The revisions to the development schedule for the card had resulted in an almost 4-year delay to the MAGR-2K-M program as of July 2021. As previously noted, Raytheon completed software development for early aviation/maritime card testing and integration in November 2021. Government verification of the software must be finished before testing and integration can be completed. In addition, after finalizing testing on receivers, the entire configuration of card, receiver, and aircraft has to undergo further testing and review to obtain airworthiness certification. Further delays to the

[23]GAO-21-145.

MAGR-2K-M receiver may arise if the program discovers new issues during early testing with this card configuration.

MGUE Increment 1 aviation/maritime card delays affected two additional aviation receiver programs. Air Force officials do not yet know the extent of delays to the delivery of the Embedded GPS Inertial Navigation System – Modernized (EGI-M), as they expect a schedule update sometime in 2022. Figure 8 shows the effect of the aviation/maritime card delay on the MAGR-2K-M and EGI-M receivers.

Figure 8: Military GPS User Equipment Increment 1 Aviation/Maritime Card Schedule Slip Effects on Aviation Receiver Development
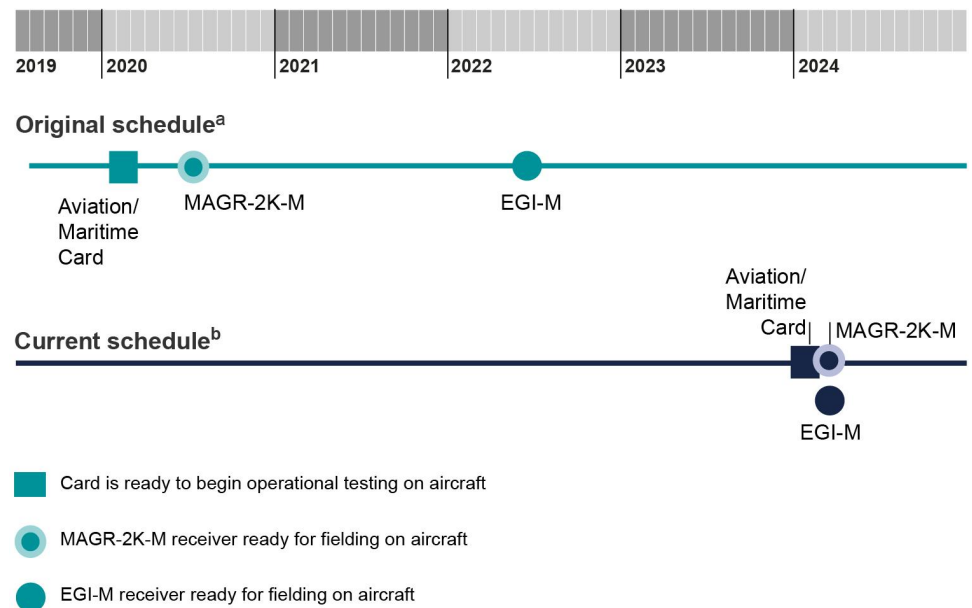
Source: GAO representation of Department of Defense information. | GAO-22-105086

[a]Original aviation/maritime card schedule approved in January 2017. Original MAGR-2K-M and EGI-M receiver schedules approved in April 2019.

[b]Current aviation/maritime card schedule approved in January 2021. Current MAGR-2K-M receiver schedule approved in July 2021. Current EGI-M schedule is tentative, program schedule update expected in 2022.

In addition to these concerns, the development of the Army's M-code receiver for aircraft, the Embedded GPS/Inertial Navigation System/Enhanced Aviation Global Air Traffic Management Localizer Performance Vertical Guidance Embedded GPS Inertial – Navigation System – M-Code (EAGLE-M), also depends on the schedule for the

Increment 1 aviation/maritime card. EAGLE-M program officials reported that their development timeline previously included some margin that delays to that card consumed. Any further delays pose a risk to the timely testing and delivery of EAGLE-M. A fourth receiver program, the Air Force's Resilient Embedded GPS Inertial Navigation System, recognizes the aviation/maritime card delays as a risk, but those delays have not yet affected its schedule.

The Navy's primary M-code receiver for surface ships—GPS-based Positioning, Navigation, and Timing Service (GPNTS)—will also use the Space Force's initial aviation/maritime card.[24] Navy officials said that the GPNTS receiver is fully developed and the service is currently fielding it on the DDG 51 class with the current, non-M-code GPS card. The Navy plans to replace this card with the aviation/maritime M-code card after GPNTS completes operational testing. While the delays to the completion of the card have not prevented the Navy from developing a usable GPNTS receiver, the delays to the card do mean that M-code capability in the maritime environment will not be fully available for several more years.

Services' Plans for M-code User Equipment Operational Testing Are Not Fully Developed

The services have progressed, to varying extents, in determining operational testing needs for the designated priority weapon systems and developing test plans. According to DOD Instruction 5000.89, the services are responsible for developing test plans, which in this case are dependent on the availability of the cards for their respective systems. An Army official said, for example, that the MAPS program will operationally test the receiver on multiple types of wheeled and tracked vehicles. While the Army is focused on Stryker and other armored weapon systems, it will conduct comprehensive testing, installation, integration, and demonstrations with each of the priority weapon systems. These activities are performed in coordination with the weapon system program managers and include laboratory as well as operational and live fire test events. Similarly, according to Navy officials, the Navy's operational testing of the GPNTS receiver on the DDG 51 class will

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[24]Navy officials told us that they plan to upgrade submarine Host Application Equipment receivers with M-code capability. GPS data are transmitted to the Host Application Equipment via a network developed under the Navy's Submarine Warfare Federated Tactical Systems program.

qualify it for fielding across multiple classes of surface vessels. Due in part to delays developing MGUE Increment 1 cards, operational testing needs for the various receivers with aviation systems are still largely undetermined and test plans are not fully developed, according to aviation receiver program officials. Finally, service officials must determine the extent to which the MGUE Increment 1 program's operational testing of the aviation/maritime card and MAGR-2K-M receiver on the B-2 bomber will apply to other aircraft.

While the services develop test plans for M-code receivers for each priority weapon system, DOT&E officials indicated that they will need to complete sufficient testing across different weapon system types. DOT&E and service officials said that when a service fields a receiver on multiple similar systems, it might only need to conduct operational tests on a subset of those systems, as with the DDG 51 class noted above. Test officials indicated that the services must create operational testing plans for M-code that do not unnecessarily duplicate test activities, but still enable collection of sufficient data to understand how M-code receivers will function on all weapon systems. DOT&E officials said that the services will have to decide what testing they need to complete across the different weapon systems. Those officials also told us they are concerned about the overall lack of operational test plans.

As previously noted, DOD acquisition policy includes operational test and evaluation as a part of the production and deployment phase of the major capability acquisition pathway.[25] DOD's test and evaluation policy states: "Service operational testing agencies will conduct operational testing on all programs to support development, fielding decisions, and warfighter understanding of capabilities and limitations."[26] Additionally, DOD policy on the implementation of PNT capabilities requires that the responsible organizations test all systems that use PNT information in realistic environments.[27] Data from operational testing inform deployment decisions, and therefore delays to operational testing can delay deployment.

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[25]DOD Instruction 5000.85, *Major Capability Acquisition* (Aug. 6, 2020).

[26]DOD Instruction 5000.89, *Test and Evaluation* (Nov. 19, 2020).

[27]DOD Instruction 4650.08, *Positioning, Navigation, and Timing and Navigation Warfare* (Dec. 17, 2018, change 1 effective Dec. 30, 2020).

Further, completing operational test plans requires considerable advance planning. DOD policy for operational testing directs the lead test organizations for weapon system programs to provide a briefing to the DOT&E on early operational test plans at least 180 days prior to the start of testing.[28] In addition, DOT&E and MGUE program officials said the services cannot test GPS user equipment anti-jam and anti-spoof capabilities without input and approval from federal civilian aviation officials, as such testing can affect civil aviation.[29] These officials said this process generally takes several months. DOT&E and service officials said the availability of systems for operational testing also complicates planning, because many assets are only available for testing when they require maintenance or upgrades. Early planning for operational testing is necessary to ensure that test authorities can schedule their activities during the limited periods when assets are available.

The PNT Oversight Council tasked the services with developing plans for operational testing need for user equipment integration by December 30, 2021, but as of March 2022, a CIO official indicated these plans are still in development with varying levels of maturity. MGUE Increment 1 delays led to uncertainty as to when the program would deliver initial M-code cards. Some priority weapon systems, especially maritime and aviation systems, depend on the Increment 1 program to complete operational testing of the same or similar user equipment as what they plan to integrate. DOT&E officials reported that, in some cases, the services have been reluctant to plan what systems require testing and when, because they were not sure when initial M-code user equipment would be available. They noted that once user equipment becomes available, the services will likely be more focused on testing. To further this, DOT&E is developing test guidance for M-code user equipment to standardize future operational testing of weapon systems that integrate derivative M-code equipment.

Because test plans have not been developed, timely fielding of M-code capability on priority systems is at risk. To deliver M-code capability to priority systems in time to meet future operational needs, the services will need to fully develop plans for operational testing of the receivers that

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[28]DOD Instruction 5000.89, *Test and Evaluation* (Nov. 19, 2020).

[29]According to DOT&E officials, even a small jammer can affect a large area and can affect civil aircraft. Coordination of testing that involves jamming, such as consolidating test events, is therefore needed to minimize this potential effect.

they plan to field on those systems, once M-code cards are available for testing.

Services Beginning to Develop Fielding Plans But Are Dependent on Testing and Other Factors

The services developed classified plans for installing and fielding M-code receivers on priority systems and are progressing, to varying degrees, toward achieving those plans. The services based those plans on a future operational scenario and, as with plans for operational testing, their maturity largely corresponds to the type of card used. Plans for fielding M-code-capable ground systems reflect the highest maturity, corresponding to the MGUE Increment 1 ground card's readiness for operational testing. Plans for maritime and aviation systems are less well-defined, due in part to delays in the development of the Increment 1 aviation/maritime card. Of those systems, planning for maritime systems is furthest along, given the expected applicability of operational testing on the DDG 51 class to other surface vessels. Technical challenges with the aviation/maritime card resulted in a slower maturation of integration plans for aviation systems, which are the most technically complex.

An official from OUSD(A&S) said there are funding disconnects between the priority list and the services' plans for fielding M-code capability. The official noted that, to address funding issues, the services received additional funds to accelerate fielding of M-code receiver equipment on some aviation systems once cards that meet technical requirements are available, and that OSD intends to mitigate these funding disconnects as part of its fiscal year 2023 budget review. Service and OSD officials indicated that challenges also arise when services decide to divest weapon systems. Specifically, services can make modernization plans spanning several years, but continued delays to M-code receiver equipment in some cases render those plans unachievable as systems age. For example, as we reported in January 2021, delays with the Increment 1 aviation/maritime card led the Navy to determine that decommissioning plans for older F/A-18 aircraft precluded upgrading them with M-code user equipment.[30] The Air Force is also looking to retire some aircraft, which could make M-code planning across all Air Force systems more difficult.

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[30]GAO-21-145.

The services' plans for installation and fielding must take weapon systems' specific scheduling needs into account. As with the integration needed to conduct operational testing of M-code equipment on systems, the services will also have to determine when fleet-wide installation can occur based on the availability of those systems to receive M-code user equipment. For instance, Navy officials said that because the Navy must install M-code upgrades for the DDG 51 class when the ships are in port, it must time these efforts to coincide with maintenance availability schedules. Similarly, Air Force officials noted that in most instances the Air Force will install M-code equipment on aircraft in conjunction with other upgrades.

Further, OSD and service officials noted that the Air Force and Navy tend to conduct modernization efforts by weapon system, while the Army does so by combat brigades. This means that when the Army modernizes a brigade, it has to equip multiple weapon systems simultaneously, not all of which will have the same receiver. Army officials indicated that this is to ensure that the forces most likely to need M-code first in a potential conflict are so equipped. One OSD official noted that for aviation platforms, services might similarly need to make decisions about whether to upgrade entire fleets or just designated assets in order to meet future operational needs.

Conclusions

DOD is approaching critical decisions with regard to planning for fielding equipment capable of receiving and using the advanced M-code GPS signal. The DOD CIO's PNT Data Repository is a critical tool for both DOD and the congressional defense committees for maintaining oversight and facilitating planning for integration of M-code across DOD weapon systems. As the cards become available, these data can be refined and validated through formal processes to reflect operational needs. Without data that is complete, consistent, and up-to-date, DOD cannot effectively plan and budget for the fielding of M-code across the myriad of weapon systems that require this crucial capability. Similarly, the congressional defense committees do not have sufficient information to facilitate oversight such as tracking progress and making funding decisions. Additionally, due to delays in user equipment development, service plans for testing M-code capability in an operational environment are not fully developed. DOD requires plans for operational testing prior to fielding to ensure equipment will function as intended. Without such plans—

especially for priority systems—DOD risks not being able to provide warfighters with a crucial capability as planned.

Recommendations for Executive Action

We are making the following seven recommendations: one to DOD and two each to the Army, Navy, and Air Force:

As Increment 1 of the user equipment completes testing, the Secretary of Defense should ensure that the DOD CIO formalizes a process to maintain information in the database that is sufficient to support priorities for budget planning and fielding M-code and to validate this information on a recurring basis. (Recommendation 1)

As Increment 1 of the user equipment completes testing, the Secretary of the Army should formalize processes to ensure that the information it provides to the CIO's PNT database is sufficient to support priorities for budget planning and fielding M-code and to validate this information on a recurring basis. (Recommendation 2)

As Increment 1 of the user equipment completes testing, the Secretary of the Navy should formalize processes to ensure that the information it provides to the CIO's PNT database is sufficient to support priorities for budget planning and fielding M-code and to validate this information on a recurring basis. (Recommendation 3)

As Increment 1 of the user equipment completes testing, the Secretary of the Air Force should formalize processes to ensure that the information it provides to the CIO's PNT database is sufficient to support priorities for budget planning and fielding M-code and to validate this information on a recurring basis. (Recommendation 4)

The Secretary of the Army should finalize the Army's operational test plans for priority systems to ensure operational testing can occur once cards become available and that the services can field equipment in time to meet future operational scenarios. (Recommendation 5)

The Secretary of the Navy should finalize the Navy's operational test plans for priority systems to ensure operational testing can occur once cards become available and that the services can field equipment in time to meet future operational scenarios. (Recommendation 6)

The Secretary of the Air Force should finalize the Air Force's operational test plans for priority systems to ensure operational testing can occur once cards become available and that the services can field equipment in time to meet future operational scenarios. (Recommendation 7)

Agency Comments and Our Evaluation

We provided a draft of this report to the Department of Defense for review and comment. In its written comments, reproduced in appendix II, DOD partially concurred with recommendations 1 through 4, and concurred with recommendations 5 through 7. For recommendations 1 through 4, DOD suggested we substitute "formalize" for "establish" or "develop," based on actions the CIO and services have recently undertaken to improve data validation. In keeping with our findings, we made the suggested wording changes. DOD also provided technical comments, 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 Air Force, the Secretary of the Army, the Secretary of the Navy, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions concerning this report, please contact me at (202) 512-4841 or ludwigsonj@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.

Jon Ludwigson
Director, Contracting and National Security Acquisitions

List of Committees

The Honorable Jack Reed
Chairman
The Honorable James M. Inhofe
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Jon Tester
Chairman
The Honorable Richard C. Shelby
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

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

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

Appendix I: Objectives, Scope, and Methodology

Section 1621 of the National Defense Authorization Act (NDAA) for Fiscal Year 2016 included a provision that the Air Force provide quarterly reports and supporting documentation to us on, among other things, next-generation GPS acquisition programs. The act also included a provision that GAO brief congressional defense committees on the first report, and at GAO's discretion, on subsequent reports. We published reports on the overall GPS enterprise, on schedule risks to the ground control segment of the GPS mission, and on progress and challenges delivering modernized GPS user equipment, in December 2017, May 2019, and January 2021, respectively. The Senate Report accompanying the NDAA for Fiscal Year 2020 included a provision that GAO examine the military services' determinations on M-code-capable user equipment needs for their weapon systems and brief the congressional defense committees on these findings. This report examines:

1. the Space Force's progress on all three segments of the GPS enterprise, including its management of risks;

2. the extent to which DOD and the services have identified and prioritized systems to field with M-code-capable equipment; and

3. the extent to which the services have planned for the procurement, installation, and fielding of M-code-capable user equipment onto priority weapon systems.

To assess the Space Force's progress toward modernization of the space, ground, and user equipment segments of the GPS enterprise, as well as the alignment of programs across segments, we reviewed documents provided by the Space Force's Space Systems Command. These include program-specific and integrated GPS program schedules, monthly acquisition reports for GPS enterprise programs, cost estimates, and other reports describing program accomplishments, setbacks, and risks. We also reviewed Space Systems Command's risk management plan for the GPS enterprise to assess how it manages risk at an enterprise level. In addition, to understand how Space Systems Command assigns responsibilities and communicates information across the GPS enterprise, we conducted interviews with officials representing Space Systems Command's Portfolio Architect and Production Corps

divisions. We also interviewed officials from the Military GPS User
Equipment (MGUE), Next Generation Operational Control System (OCX),
GPS III, and GPS IIIF program offices.

To determine the extent to which DOD and the services identified and
prioritized systems to field with M-code-capable equipment, we reviewed
documents from the Office of the DOD Chief Information Officer (CIO)
and classified briefing materials from the Positioning, Navigation, and
Timing (PNT) Oversight Council. We reviewed the CIO's PNT Data
Repository by examining budget and M-code integration information for
priority weapon systems to determine whether data appeared to be
complete. To assess DOD's process for collecting data on M-code
integration plans, we interviewed officials from the office of the DOD CIO
and the Office of the Under Secretary of Defense for Acquisition and
Sustainment. We also interviewed cross-functional teams for PNT in each
service to understand their roles in planning for M-code integration within
their respective service. These included:

- The Office of the Deputy Chief of Naval Operations for Information
  Warfare,

- The Air Force's Resilient Positioning, Navigation, and Timing Cross-
  Functional Team, and

- The Army's Cross-Functional Team for Positioning, Navigation, and
  Timing.

We also determined that the control activities component of internal
control was significant to this objective, along with the underlying
principles that management should design and implement control
activities to achieve its objectives. We assessed the extent to which the
DOD CIO designed and implemented control activities to ensure
information in its PNT database is sufficient to support priorities for
budget planning and fielding M-code.

To examine the extent to which the services planned for the procurement,
installation, and fielding of M-code-capable user equipment for priority
weapon systems, we reviewed the MGUE Increment 1 program's updated
acquisition program baseline, monthly acquisitions reports, and other
briefings relevant to the program's progress delivering usable M-code
cards. We interviewed MGUE Increment 1 program officials and M-code
card contractors to obtain insight into progress and challenges in
delivering M-code cards.

To understand the actions DOD has taken to mitigate the effects of
microelectronics supply issues on M-code delivery, we interviewed
officials from the Defense Logistics Agency about their bulk buy of
application-specific integrated circuits for Increment 1 M-code cards. To
determine the progress the services made in developing M-code
receivers, selecting receiver solutions for priority weapon systems, and
developing operational test plans for this equipment, we reviewed
modernized receiver programs' baseline and schedule documents and
interviewed officials from service-level offices overseeing the
development and integration of M-code receivers.

To understand M-code user equipment operational testing needs, we
interviewed officials from the office of the Director, Operational Testing
and Evaluation and military service PNT officials. We compared
information on operational testing plans for selected weapon systems and
delivery dates for M-code receivers to DOD's future operational needs.
Finally, we examined DOD's classified M-code equipment fielding plans
and assessed the extent to which they align with timelines for developing
M-code equipment.

We conducted this performance audit from March 2021 to May 2022 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

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION
AND SUSTAINMENT

Mr. Jon Ludwigson
Director, Defense Capabilities and Management
U.S. Government Accountability Office
441 G Street, NW
Washington DC 20548

Dear Mr. Ludwigson:

This is the Department of Defense response to the GAO Draft Report, GAO-22-105086, 'GPS MODERNIZATION: Better Information and Detailed Test Plans Needed for Timely Fielding of Military User Equipment,' dated March 18, 2022 (GAO Code 105086).

The Department is providing official written comments for inclusion in the report. The Department concurs with recommendations 5-7 and partially concurs with recommendations 1-4. Rationale for the partially concurs are detailed in the Summary of Recommendations and the official written comments.

Sincerely,

Gary A. Ashworth
Deputy Assistant Secretary of Defense
Strategic, Space, and Intelligence
Portfolio Management

Enclosure:
As stated

GAO DRAFT REPORT DATED MARCH 17, 2022
GAO-22-105086 (GAO CODE 105086)

"GPS MODERNIZATION: Better Information and Detailed Test Plans Needed for
Timely Fielding of Military User Equipment"

DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATIONS

RECOMMENDATION 1: As Increment 1 of the user equipment completes testing, the
Secretary of the Defense should ensure that the DOD CIO establishes a process to maintain
information in the database that is sufficient to support priorities for planning and fielding M-
code and to validate this information on a recurring basis.
(Recommendation 1)

DoD RESPONSE: DoD partially concurs with Recommendation 1. DoD suggests that GAO
substitute "formalize" in lieu of "establish". Rationale: The DoD CIO has established processes
in place to maintain information in the database. The DoD CIO is in the process of formalizing
those existing processes and will share them with GAO once finalized.

RECOMMENDATION 2: As Increment 1 of the user equipment completes testing,
the Secretary of the Army should develop a process to ensure that the information
that it provides to the PNT CIO's database is sufficient to support priorities for
budget planning and fielding M-code to validate this information on a recurring
basis. (Recommendation 2)

DoD RESPONSE: DoD partially concurs with Recommendation 2. DoD suggests that GAO
substitute "formalize" in lieu of "establish". Rationale: The Army has established processes in
place to maintain information in the database. The Army is in the process of formalizing those
existing processes and will share them with GAO once finalized.

RECOMMENDATION 3: As Increment 1 of the user equipment completes testing, the
Secretary of the Navy should develop a process to ensure that the information that it provides to
the PNT CIO's database is sufficient to support priorities for budget planning and fielding M-
code to validate this information on a recurring basis.   (Recommendation 3)

DoD RESPONSE: DoD partially concurs with Recommendation 3. DoD suggests that GAO
substitute "formalize" in lieu of "establish". Rationale: The Navy has established processes in
place to maintain information in the database. The Navy is in the process of formalizing those
existing processes and will share them with GAO once finalized.

RECOMMENDATION 4: As Increment 1 of the user equipment completes testing, the
Secretary of the Air Force should develop a process to ensure that the information that it

2

provides to the PNT CIO's database is sufficient to support priorities for budget planning and fielding M-code to validate this information on a recurring basis. (Recommendation 4)

DoD RESPONSE: DoD partially concurs with Recommendation 4. DoD suggests that GAO substitute "formalize" in lieu of "establish". Rationale: The Air Force has established processes in place to maintain information in the database. The Air Force is in the process of formalizing those existing processes and will share them with GAO once finalized.

RECOMMENDATION 5. The Secretary of the Army should finalize the Army's operational test plans for priority systems to ensure operational testing can occur once cards become available and that the services can field equipment in time to meet future operational scenarios. (Recommendation 5)

DoD RESPONSE: DoD concurs with Recommendation 5.

RECOMMENDATION 6: The Secretary of the Navy should finalize the Navy's operational test plans for priority systems to ensure operational testing can occur once cards become available and that the services can field equipment in time to meet future operational scenarios. (Recommendation 6)

DoD RESPONSE: DoD concurs with Recommendation 6.

RECOMMENDATION 7: The Secretary of the Air Force should finalize the Air Force's operational test plans for priority systems to ensure operational testing can occur once cards become available and that the services can field equipment in time to meet future operational scenarios. (Recommendation 7)

DoD RESPONSE: DoD concurs with Recommendation 7.

Text of Appendix II: Comments from the Department of Defense

Mr. Jon Ludwigson

Director, Defense Capabilities and Management

U.S. Government Accountability Office 441 G Street, NW

Washington DC 20548

Dear Mr. Ludwigson:

This is the Department of Defense response to the GAO Draft Report, GAO-22-105086, 'GPS MODERNIZATION: Better Information and Detailed Test Plans Needed for Timely Fielding of Military User Equipment,' dated March 18, 2022 (GAO Code 105086).

The Department is providing official written comments for inclusion in the report. The Department concurs with recommendations 5-7 and partially concurs with recommendations 1-4. Rationale for the partially concurs are detailed in the Summary of Recommendations and the official written comments.

Sincerely,

Gary A. Ashworth

Deputy Assistant Secretary of Defense Strategic, Space, and Intelligence Portfolio Management

Enclosure:

As stated

GAO DRAFT REPORT DATED MARCH 17, 2022 GAO-22-105086 (GAO CODE 105086)

<u>"GPS MODERNIZATION: Better Information and Detailed Test Plans Needed
for Timely Fielding of Military User Equipment" DEPARTMENT OF DEFENSE
COMMENTS TO THE GAO RECOMMENDATIONS</u>

**RECOMMENDATION 1: As Increment 1 of the user equipment completes
testing, the Secretary of the Defense should ensure that the DOD CIO
establishes a process to maintain information in the database that is sufficient
to support priorities for planning and fielding M- code and to validate this
information on a recurring basis. (Recommendation 1)**

DoD RESPONSE: DoD partially concurs with Recommendation 1. DoD suggests
that GAO substitute "formalize" in lieu of "establish". Rationale: The DoD CIO has
established processes in place to maintain information in the database. The DoD
CIO is in the process of formalizing those existing processes and will share them
with GAO once finalized.

**RECOMMENDATION 2: As Increment 1 of the user equipment completes
testing, the Secretary of the Army should develop a process to ensure that the
information that it provides to the PNT CIO's database is sufficient to support
priorities for budget planning and fielding M-code to validate this information
on a recurring basis. (Recommendation 2)**

DoD RESPONSE: DoD partially concurs with Recommendation 2. DoD suggests
that GAO substitute "formalize" in lieu of "establish". Rationale: The Army has
established processes in place to maintain information in the database. The Army is
in the process of formalizing those existing processes and will share them with GAO
once finalized.

**RECOMMENDATION 3: As Increment 1 of the user equipment completes
testing, the Secretary of the Navy should develop a process to ensure that the
information that it provides to the PNT CIO's database is sufficient to support
priorities for budget planning and fielding M- code to validate this information
on a recurring basis. (Recommendation 3)**

DoD RESPONSE: DoD partially concurs with Recommendation 3. DoD suggests
that GAO substitute "formalize" in lieu of "establish". Rationale: The Navy has
established processes in place to maintain information in the database. The Navy is
in the process of formalizing those existing processes and will share them with GAO
once finalized.

**RECOMMENDATION 4: As Increment 1 of the user equipment completes
testing, the Secretary of the Air Force should develop a process to ensure that
the information that it provides to the PNT CIO's database is sufficient to
support priorities for budget planning and fielding M-code to validate this
information on a recurring basis. (Recommendation 4)**

DoD RESPONSE: DoD partially concurs with Recommendation 4. DoD suggests
that GAO substitute "formalize" in lieu of "establish". Rationale: The Air Force has
established processes in place to maintain information in the database. The Air
Force is in the process of formalizing those existing processes and will share them
with GAO once finalized.

**RECOMMENDATION 5. The Secretary of the Army should finalize the Army's
operational test plans for priority systems to ensure operational testing can
occur once cards become available and that the services can field equipment
in time to meet future operational scenarios. (Recommendation 5)**

DoD RESPONSE: DoD concurs with Recommendation 5.

**RECOMMENDATION 6: The Secretary of the Navy should finalize the Navy's
operational test plans for priority systems to ensure operational testing can
occur once cards become available and that the services can field equipment
in time to meet future operational scenarios. (Recommendation 6)**

DoD RESPONSE: DoD concurs with Recommendation 6.

**RECOMMENDATION 7: The Secretary of the Air Force should finalize the Air
Force's operational test plans for priority systems to ensure operational
testing can occur once cards become available and that the services can field
equipment in time to meet future operational scenarios. (Recommendation 7)**

DoD RESPONSE: DoD concurs with Recommendation 7.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Jon Ludwigson, (202) 512-4841 or ludwigsonj@gao.gov

Staff Acknowledgments

In addition to the contact named above, the following staff members made key contributions to this report: J. Kristopher Keener (Assistant Director), Andrew H. Redd (Analyst-in-Charge), Pete Anderson, Susan C. Ditto, Jonathan Mulcare, Sylvia Schatz, Kimberly Schuster, Rachel Wexler, and Robin Wilson.

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