United States Government Accountability Office

Report to Congressional Committees

May 2017

MISSILE DEFENSE

Some Progress Delivering Capabilities, but Challenges with Testing Transparency and Requirements Development Need to Be Addressed

Accessible Version

GAO-17-381

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GAO Highlights

Highlights of GAO-17-381, a report to congressional committees

Why GAO Did This Study

Since 2002, MDA has been developing a Ballistic Missile Defense System comprised of a command and control system, radars that can identify incoming threats, and intercepting missiles. MDA has received approximately $123 billion and is planning to spend an additional $37 billion through fiscal year 2021 to continue its efforts.

The National Defense Authorization Act for Fiscal Year 2012 included a provision that GAO assess the extent to which MDA has achieved its acquisition goals and objectives. This report addresses the progress and challenges in fiscal year 2016 associated with MDA: (1) achieving fiscal year 2016 testing, asset, and capability delivery goals, (2) ensuring transparency of test schedules and costs, and (3) establishing a sound business case for future efforts. GAO reviewed the planned fiscal year 2016 baselines as stated in the BMDS Accountability Report and other program documentation and assessed them against program and baseline reviews and GAO's acquisition best practices guides. In addition, GAO interviewed DOD and MDA officials.

What GAO Recommends

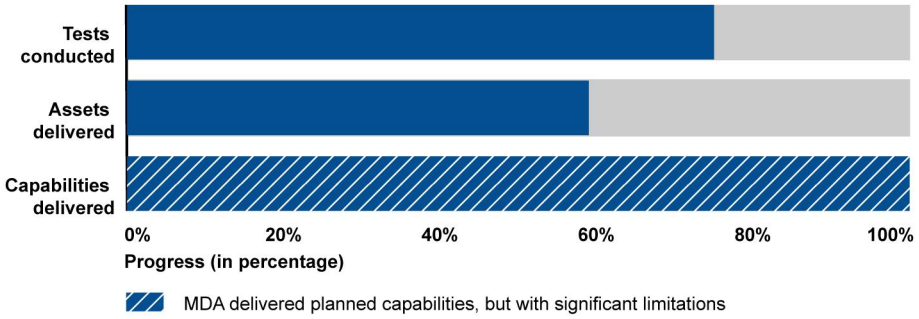
GAO is making four recommendations to the Department of Defense to increase transparency into testing and cost estimates, and improve acquisition strategies for MDA's future efforts. DOD concurred with part of GAO's first recommendation, but it did not concur with the remaining parts or other three recommendations. GAO continues to believe the recommendations are valid as discussed in this report.

View GAO-17-381. For more information, contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov.

What GAO Found

In fiscal year 2016, the Missile Defense Agency (MDA) made some progress in achieving its testing and delivery goals for individual elements of the Ballistic Missile Defense System (BMDS) and for capabilities that can be derived when individual elements are combined (known as BMDS level capabilities), but it was not able to complete its planned fiscal year goals. Specifically, MDA conducted 10 flight tests, including a major operational test, but it had to delay others, limiting the knowledge gained in fiscal year 2016. In addition, MDA delivered new interceptors, upgraded fielded interceptors and delivered five BMDS level capabilities. However, testing revealed that the BMDS level capabilities delivered will not likely provide robust defense as planned. The figure below highlights key progress MDA made for fiscal year 2016 against its planned goals.

Figure: Missile Defense Agency's Progress for Fiscal Year 2016 Against Planned Goals



Source: GAO analysis of Missile Defense Agency data. | GAO-17-381

MDA's integrated test schedule continues to be aggressive, resulting in frequent changes to planned testing from year to year. These changes are not clearly tracked which reduces the traceability of planned test objectives—what requirements have been met and when. Furthermore, MDA requests more than $1 billion in funding each fiscal year for tests, but the cost estimates to support the request are inconsistent and lack transparency. Until MDA addresses the limited traceability in its test schedule and transparency of the associated costs, the ability to track test progress costs will remain difficult.

MDA's efforts for exploring, developing, producing, and delivering its next generation of capabilities, such as new ground-, air-, and space-based sensors and interceptors, include several best practices of a sound business case. For example, MDA plans to incorporate mature technologies and realistic cost estimates in its efforts. However, the process lacks warfighter-approved requirements and sufficient input from Department of Defense (DOD) components. For example, design approaches for several efforts include trade-offs that favor acquiring capabilities sooner and at a lower cost but are at risk of lacking the performance necessary to defeat future threats. By allowing MDA to define requirements but not address concerns with system designs and acquisition strategies, there is an undue level of emphasis being placed on the judgment, needs, and preferences of MDA ahead of the warfighter, decreasing DOD-wide support for some future efforts.

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Abbreviations

AA	Aegis Ashore
ACL	Achievable Capabilities List
ADT	Alternate Divert Thrusters
Aegis BMD	Aegis Ballistic Missile Defense
AN/TPY-2	Army Navy/Transportable Radar Surveillance and Control Model 2
AWS	Aegis Weapon System
BAR	BMDS Accountability Report
BMD	Ballistic Missile Defense
BMDS	Ballistic Missile Defense System
CAPE	Cost Assessment and Program Evaluation
C2BMC	Command, Control, Battle Management, and Communications
CE-I	Capability Enhancement-I
CE-II	Capability Enhancement-II
CENTCOM	United States Central Command
COCOM	Combatant Command
CTV	Control Test Vehicle
CU	Capability Upgrade
DASD (DT&E)	Deputy Assistant Secretary of Defense for Developmental Test and Evaluation
DOD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
eMRBM	Extended Medium Range Ballistic Missile
EOR	Engage on Remote
EPAA	European Phased Adaptive Approach
EKV	Exoatmospheric Kill Vehicle
EUCOM	United States European Command
FTG	Flight Test Ground-based Interceptor
FTM	Flight Test Standard Missile
FTO	Flight Test Operational
FTT	Flight Test THAAD Interceptor
FTX	Flight Test Other
FY	Fiscal Year
GBI	Ground-based Interceptor
GMD	Ground-based Midcourse Defense
GTD	Ground Test Distributed
GTI	Ground Test Integrated
ICBM	Intercontinental Ballistic Missile
IMTP	Integrated Master Test Plan

JCIDS	Joint Capabilities Integration and Development System
JFCC IMD	Joint Functional Component Command for Integrated Missile Defense
JROC	Joint Requirements Oversight Council
LRDR	Long Range Discrimination Radar
MDA	Missile Defense Agency
MDEB	Missile Defense Executive Board
MIP	Master Integration Plan
MOKV	Multi-Object Kill Vehicle
NDAA	National Defense Authorization Act
NMCC	National Military Command Center
NORTHCOM	United States Northern Command
OTA	Operational Test Agency
PAA	Phase Adaptive Approach
PAC-3	Patriot Advanced Capability-3
PACOM	United States Pacific Command
PCL	Prioritized Capabilities List
RKV	Redesigned Kill Vehicle
SCD	SM-3 Cooperative Development Program
SFTM	SCD Flight Test Standard Missile
SKA	Space-based Kill Assessment
SM-3	Standard Missile-3
STRATCOM	United States Strategic Command
TRMP-T	Test Resources Mission Planning-Tool
TSRM	Third Stage Rocket Motor
TU	Threat Upgrade
THAAD	Terminal High Altitude Area Defense
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology and Logistics
WBS	Work Breakdown Structure

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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May 30, 2017

Congressional Committees

Since 2002, the Missile Defense Agency (MDA) has received approximately $123 billion to develop, integrate, and deliver the Ballistic Missile Defense System (BMDS). MDA is planning to spend an additional $37 billion through fiscal year 2021 to continue its efforts to develop the system to detect, track, and defeat enemy ballistic missiles. To date, we have provided 13 reports covering MDA's annual progress and made recommendations to address challenges in developing and fielding BMDS capabilities, as well as other transparency, accountability, and oversight issues.[1] While MDA has taken steps to implement some of our recommendations, going forward, it will continue to face important challenges as it works to develop, integrate, and deliver capability, increase transparency, and strengthen its investment decisions.

Various National Defense Authorization Acts since 2002 have included provisions for us to prepare annual assessments of MDA's progress toward meeting its acquisition goals.[2] Specifically, the National Defense Authorization Act for Fiscal Year 2012, as amended, required us to report annually on the extent to which MDA has achieved its acquisition goals and objectives, as reported in its acquisition baselines in the BMDS Accountability Report (BAR), and include any other findings and recommendations on MDA's acquisition programs and accountability, as appropriate.[3] This year, to fulfill our responsibilities under the mandate, our review addresses the: (1) progress, if any, MDA and its missile defense elements made in achieving its fiscal year 2016 testing and delivery goals; (2) transparency of test schedules and costs; and (3)

[1]Related GAO products are listed at the end of this report.

[2]National Defense Authorization Act for Fiscal Year 2002, Pub. L. No. 107-107, § 232(g) (2001); Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, Pub. L. No. 108-375, § 233 (2004); National Defense Authorization Act for Fiscal Year 2006, Pub. L. No. 109-163, § 232; John Warner National Defense Authorization Act for Fiscal Year 2007, Pub. L. No. 109-364, § 224 (2006); National Defense Authorization Act for Fiscal Year 2008, Pub. L. No. 110-181, § 225; and National Defense Authorization Act for Fiscal Year 2012, Pub. L. No. 112-81, § 232 (2011).

[3]Pub. L. No. 112-81, § 232 (a) (2011). The National Defense Authorization Act for Fiscal Year 2016 extended our reviews through fiscal year 2020. See Pub. L. No. 114-92 §1688 (2015).

extent to which MDA has established a sound business case for future efforts.

For this report, we focused on MDA's testing, asset and BMDS level delivery goals. To assess MDA's fiscal year 2016 progress towards meeting its testing, asset and BMDS level capability goals, we reviewed the planned baselines as stated in the BAR approved February 20, 2015, that aligns with their fiscal year 2016 budget request and systems engineering documents, including the recent Master Integration Plans approved October 2015 and May 2016. These documents contain MDA's plans for the fiscal year. We compared the planned efforts to annual progress as detailed in key management documents, including program and baseline reviews, as well as flight test plans. In addition, we assessed MDA responses to GAO questionnaires that we provided to certain BMDS elements included in this report to obtain program information on fiscal year testing and asset delivery progress, along with program plans to reduce acquisition risks. Lastly, we reviewed available system engineering and integration planning documents—including prior years' Master Integration Plans, which contain descriptions, risks, and schedules for BMDS level capability deliveries—and MDA responses to GAO data collection instruments. We also met with officials MDA program offices, from the BMDS Operational Test Agency, Office of the Deputy Assistant Secretary of Defense for Developmental Test and Evaluation, and MDA's Testing and Engineering Directorates to discuss issues surrounding testing and delivering capabilities.

To assess the transparency of test schedules and costs, we reviewed MDA's integrated test schedule, MDA's testing policies, and other relevant documentation to determine testing progress to date. We compared MDA's schedules against best practices in the GAO's Schedule Assessment Guide and assessed specifically two individual test schedules, FTT-18 and GTI-07A, to determine the extent to which they reflected key estimating practices that are fundamental to having a reliable schedule.[4] We also evaluated the extent to which MDA scheduling guidance aligned with leading schedule estimating practices from GAO's Schedule Assessment Guide.[5] For the test cost estimates, we analyzed both element and test level cost estimates and assessed

[4]GAO, *GAO Schedule Assessment Guide: Best Practices for Project Schedules,* GAO-16-89G (Washington, D.C.: Dec. 22, 2015).

[5]GAO-16-89G.

them against leading cost estimating practices identified in the GAO's Cost Estimating and Assessment Guide.[6] We also met with MDA officials from various programs, including Terminal High Area Altitude Defense and Targets and Countermeasures and MDA's Directorates for Cost and Testing to discuss cost estimating practices. In addition, we met with DOD's Cost Assessment and Program Evaluation office.

To assess the extent to which MDA has established a sound business case for its next generation BMDS capabilities, we determined which efforts constituted MDA's next generation efforts by reviewing MDA's fiscal year 2017 budget request and identified efforts that were projected to be fielded in or around fiscal years 2020 through 2025 and beyond. Where available, we assessed the acquisition plans of these efforts against GAO's identified best practices for establishing a sound business case that were previously developed in our work on defense acquisitions.[7] To discuss the next generation efforts, we met with MDA officials from the Advanced Technology, GMD, and Sensors programs, as well as from the office of the Director for Engineering. We also met with officials from DOD's Office of Director of Operational Test and Evaluation, Office of the Deputy Assistant Secretary of Defense for Developmental Test and Evaluation, DOD's Cost Assessment and Program Evaluation office, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, U.S. Northern Command, Joint Functional Component Command for Integrated Missile Defense, and selected contractors.

We conducted this performance audit from May 2016 to May 2017 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

[6]*GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs (Supersedes* GAO-07-1134SP*),* GAO-09-3SP (Washington, D.C.: Mar. 2, 2009).

[7]For examples, see GAO, *Defense Acquisitions: Joint Action Needed by DOD and Congress to Improve Outcomes,* GAO-16-187T (Washington, D.C.: Oct. 27, 2015); *Defense Acquisitions: Sound Business Case Needed to Implement Missile Defense Agency's Targets Program*, GAO-08-1113 (Washington, D.C.: Sep. 26, 2008); *Defense Acquisitions: Improved Business Case Is Needed for Future Combat System's Successful Outcome*, GAO-06-367 (Washington, D.C.: Mar. 14, 2006); and *Best Practices: A More Constructive Test Approach Is Key to Better Weapon System Outcomes*, GAO-00-199 (Washington, D.C.: July 31, 2000).

the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

MDA is developing a variety of systems, known as elements, to enable the warfighter to defend against enemy ballistic missiles. The ultimate goal is to integrate these various elements to function as a single system, the BMDS. Table 1 provides a list and description of certain elements included in our review and appendixes II-IX contain more detailed information on their fiscal year 2016 activities.

Table 1: Description of Ballistic Missile Defense System (BMDS) Elements[a]

BMDS elements	Description
Aegis Ballistic Missile Defense (BMD) Weapon System	Aegis BMD includes ship- and land-based ballistic missile defense capabilities using a radar, command and control, and Standard Missile-3 (SM-3) interceptors. It is included on certain Navy ships and Aegis Ashore sites.
Aegis BMD Standard Missile-3 SM-3 Block IB	Aegis BMD SM-3 Block IB features capabilities to identify, discriminate, and track objects during flight to defend against short-, medium-, and intermediate-range ballistic missiles threats. The program is currently developing an upgrade to the interceptor called the Aegis BMD SM-3 Block IB Threat Upgrade (TU).
Aegis BMD SM-3 Block IIA	Aegis BMD SM-3 Block IIA has increased range, more sensitive seeker technology, and an advanced kill vehicle from the Aegis BMD SM-3 Block IA to defend against medium- and intermediate-range ballistic missiles.[a]
Aegis Ashore	Aegis Ashore, a land-based version of Aegis BMD, uses SM-3 interceptors and Aegis BMD capabilities as they become available and will have three locations: one test site and two operational sites.
Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2)	AN/TPY-2 is a transportable X-band high-resolution radar capable of tracking ballistic missiles of all ranges that can be used in two modes: (1) forward-based mode—to support Aegis BMD and Ground-based Midcourse Defense, or (2) terminal mode—to support Terminal High Altitude Area Defense. Element level upgrades for AN/TPY-2s are planned for delivery, and integration efforts have started. The radars have been have been deployed to various geographic locations including Japan and Turkey.
Command, Control, Battle Management, and Communications (C2BMC)	C2BMC is a globally deployed system of hardware—workstations, servers, and network equipment—and software that links and integrates individual elements, allowing users to plan ballistic missile defense operations, see the battle develop, and manage networked sensors.

BMDS elements	Description
Ground-based Midcourse Defense (GMD)	GMD is a ground-based system with launch, communications, and fire control components that use interceptors with a booster and a kill vehicle to defend against intermediate- and intercontinental-range ballistic missiles. There are two versions of interceptors that are currently fielded at Fort Greely, Alaska, and Vandenberg Air Force Base, California: (1) the initial kill vehicle, Capability Enhancement (CE)-I, and (2) the upgraded version, CE-II. Both versions are paired with the first generation boost vehicle. MDA is currently developing an interceptor version with an upgraded kill vehicle, called CE-II Block I, and a new, second generation boost vehicle to address obsolescence issues and problems previously discovered during flight testing.
Targets and Countermeasures[b]	Targets and Countermeasures provide a variety of highly complex short-, medium-, intermediate-, and intercontinental-range targets to represent realistic threats during BMDS flight testing.
Terminal High Altitude Area Defense (THAAD)	THAAD is a mobile, ground-based system to defend against short- and medium-range threats using a battery that consists of interceptors, launchers, a radar, and fire control and communication systems.

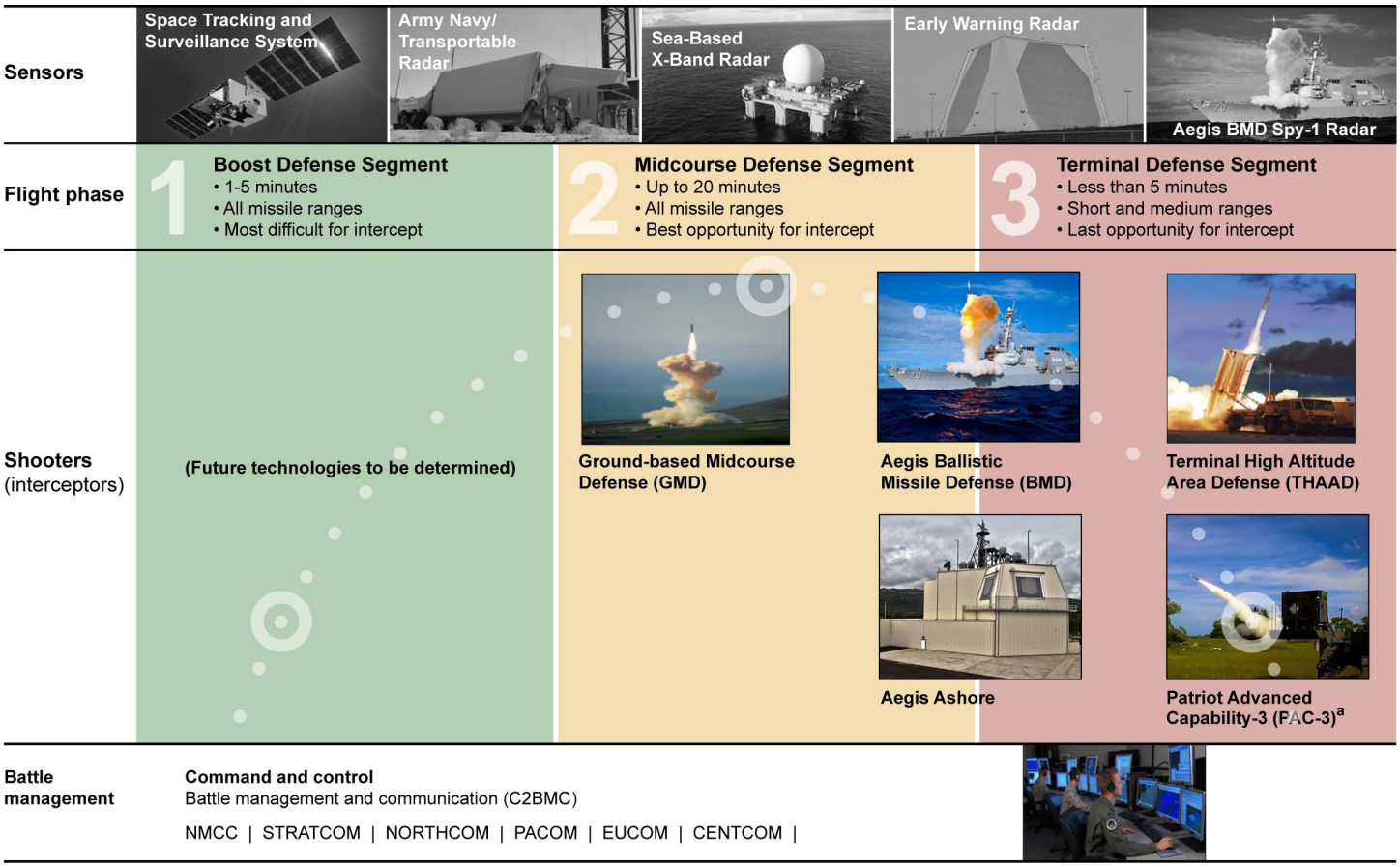
GAO analysis of MDA data. I GAO-17-381

[a]This table details the elements included in this review, but MDA is developing additional elements for the BMDS that are not included in this review because they fall outside the scope of the BAR.

[b]Target and Countermeasures provides assets to test the performance and capabilities of the BMDS elements, but these testing assets are not operationally fielded.

The elements, when integrated as the BMDS, are designed to destroy enemy ballistic missiles of various ranges, speeds, sizes, and performance characteristics in different phases of flight. Once an enemy ballistic missile has been launched, sensors and interceptors are coordinated via the command and control, battle management, and communications system to enable the warfighter to detect, track, or engage it. The performance that is derived when capabilities of individual elements are combined this way is known as BMDS level capabilities. Figure 1 shows the flight phases, intercept ranges and time frames, and the elements that make up the BMDS.

Figure 1: Ballistic Missile Defense System Architecture Overview



NMCC - National Military Command Center
STRATCOM - United States Strategic Command
NORTHCOM - United States Northern Command
PACOM - United States Pacific Command
EUCOM - United States European Command
CENTCOM - United States Central Command

Source: GAO analysis of Missile Defense Agency (MDA) data (data and images). | GAO-17-381

MDA's Acquisition Flexibilities and Steps to Improve Traceability and Oversight

When MDA was established in 2002, it was granted exceptional flexibilities to set requirements and manage the acquisition of the BMDS—developed as a single program—that allow MDA to expedite the fielding of assets and integrated ballistic missile defense capabilities. These flexibilities enable divergence from DOD's traditional acquisition lifecycle and defer the application of acquisition policies and laws designed to facilitate oversight and accountability until a mature capability

is ready to be handed over to a military service for production and operation. These laws and policies include such things as

- obtaining the approval of a higher-level acquisition executive before making changes to an approved baseline,[8]
- reporting certain increases in unit cost measured from the original or current baseline, [9]
- obtaining an independent lifecycle cost estimate prior to beginning system development and/or production and deployment,[10] and
- regularly providing detailed program status information to Congress, including specific costs, in Selected Acquisition Reports.[11]

In response to concerns related to MDA's flexibilities, Congress and DOD have taken a number of actions. For example, Congress enacted legislation in 2008 requiring MDA to establish cost, schedule, and performance baselines—starting points against which to measure progress—for each element that has entered the equivalent of system development or is being produced or acquired for operational fielding.[12] MDA reported its newly established baselines to Congress for the first time in its June 2010 BAR. Since that time, Congress has provided more detailed requirements for the content of these baselines.[13] Additionally, to enhance oversight of the information provided in the BAR, MDA has continued to incorporate suggestions and recommendations from us to include: (1) explanations or major changes experienced by each element over the past year; (2) adding buy and delivery information for each

[8] DOD Instruction 5000.02, Operation of the Defense Acquisition System, Enc. 1 para. 4 and Table 3. (Jan. 7, 2015)(incorp. change 1, eff. Jan. 26, 2017).

[9]10 U.S.C. § 2433.

[10]10 U.S.C. § 2434.

[11]10 U.S.C. § 2432.

[12]National Defense Authorization Act for Fiscal Year 2008, Pub. L. No. 110-181, § 223(g), repealed by Pub. L. No. 112-81, § 231(b)(2) (2011).

[13]See, e.g., the National Defense Authorization Act for Fiscal Year 2012, Pub. L. No. 112-81, § 231, codified at 10 U.S.C. § 225, that requires the MDA Director to establish and maintain an acquisition baseline for each program element of the BMDS and each designated major subprogram of such program elements before the date on which the program element or major subprogram enters the equivalent of engineering and manufacturing development and before production and deployment. This law details specific requirements for the contents of the acquisition baseline.

element that has advanced to production and fielding; and (3) descriptions for cost items not contained in elements' baselines. While these are positive steps, all of our prior recommendations have not yet been fully implemented.

MDA's Testing Approach

Testing, in general, is performed to collect critical data on individual elements or as the integrated BMDS to: (1) determine whether it is properly designed, built, and integrated; (2) understand its performance, including its capabilities and limitations; and (3) support next steps and decisions. MDA's testing, specifically, combines both developmental and operational, the former verifying the design will satisfy requirements and the latter demonstrating the system can successfully accomplish its mission in the hands of the warfighter under realistic conditions. In addition, MDA uses multiple methods including ground and flight testing to determine whether the element's or BMDS's design will satisfy the desired capabilities:

- Ground Testing—utilizes modeling and simulations which are computer representations that simulate the system's performance to assess the capabilities and limitations of how elements or the BMDS perform under a wider variety of conditions than can be accomplished through the limited number of flight tests conducted. Ground tests enable MDA to repeatedly conduct scenarios that may be too costly or subject to constraints as a flight test. To ensure that the models and simulations accurately represent the element or BMDS level, each undergoes verification, validation, and accreditation—an official certification that it operates as intended in representative, real-world conditions. The BMDS Operational Test Agency (OTA)—an independent assessor—performs the verification, validation, and accreditation.
- Flight Testing—includes intercept and non-intercept testing. Flight tests use actual elements to assess and demonstrate performance. Flight tests alone are insufficient because they only demonstrate a single collection data point of element and system performance. Flight tests are, however, an essential tool used to validate performance of the elements and, eventually, the BMDS. Flight tests are also necessary to anchor models and simulations and to ensure they

accurately reflect real performance.[14] Non-intercept tests enable evaluation of specific performance aspects or scenarios and potentially reduce risks for future tests.

MDA uses individual test schedules to tactically manage a single test event and the Integrated Master Test Plan (hereafter referred to as the integrated test schedule) to strategically manage all of the element and BMDS level tests. Individual test schedules are created as the execution date for a test is approaching and elaborates the specific details for each test, including assigned personnel, roles and responsibilities, dates, and tasks. Whereas MDA's testing baseline—the integrated test schedule—designates all of its element and BMDS level testing for the upcoming and future fiscal years and supports its funding requests. Specifically, it identifies each test by name, including the type of test, any targets (if applicable), and the fiscal year quarter it is planned for execution. The integrated test schedule is finalized and signed annually. Midway through the year, MDA updates the integrated test schedule with any changes in a memo that is approved by DOD testing officials. MDA has multiple lines of funding to pay for any costs associated with testing. The Director for Testing manages and executes testing using its funding lines. In addition, each MDA element has its own funding lines for testing and Targets and Countermeasures provide targets that are test assets.

MDA's Incremental Approach for Delivering BMDS level Capabilities

MDA is using an incremental approach—a series of deliveries that build upon, expand, or add to what is currently available—to deliver its BMDS level capabilities. BMDS level capabilities are intended to achieve performance levels that cannot be realized by the elements working independently, including intercepting threats sooner, defending larger areas, and countering more threats simultaneously. For example, a BMDS level capability called Engage on Remote, integrates Aegis BMD with forward-based radars and C2BMC to allow the warfighter to acquire and intercept an enemy ballistic missile sooner and, consequently, defend a larger area. BMDS capabilities, such as Engage on Remote, are grouped with others to meet specific ballistic missile defense goals and are delivered in increments. In fiscal year 2016, MDA was planning to deliver an additional 6 increments beyond the delivered Increment 2,

[14]GAO, *Defense Acquisitions: Charting a Course for Improved Missile Defense Testing* GAO-09-403T (Washington, D.C.: Feb. 25, 2009).

each consisting of 3 to 11 BMDS level capabilities. The increments and associated capabilities are to be delivered annually or bi-annually in support of presidentially directed or agency goals for Homeland and Regional defense—including the European Phased Adaptive Approach (EPAA)—as shown in table 2.[15]

Table 2: Missile Defense Agency's (MDA) Current Plan for Delivery of Ballistic Missile Defense System (BMDS) Level Capabilities

Increment	Description of capabilities	Delivery date	Number of BMDS level capabilities
Increment 2	Robust Medium Range Ballistic Missile Defense/European Phased Adaptive Approach (EPAA) Phase 2	Delivered December 2015	5 total/3 for EPAA Phase 2
Increment 3	Near Term Discrimination Improvements to Homeland Defense	December 2016[a]	3
Increment 4	BMDS Enhanced Homeland Defense	December 2017	5
Increment 5	Robust Intermediate Range Ballistic Missile Defense/ EPAA Phase 3	December 2018	7 total/ 1 for EPAA Phase 3
Increment 6	Homeland Defense and Mid Term Discrimination Improvements for Homeland Defense	December 2020	11
Increment 7	N/A[b]	December 2022	6
Increment 8	N/A[b]	December 2025	8

Source: GAO analysis of MDA data. | GAO-17-381

[a]While planned for December 2016, according to MDA officials, Near Term Improvements to the Homeland Defense were delivered and approved by the MDA Director on March 23, 2017.

[b]MDA officials told us that they are moving away from naming the increments or focusing on regional vs. homeland defense missions as future ones are planned to include a mix of regional and homeland capabilities in each increment.

Most of the planned increments focus on defending the United States homeland against intermediate- and intercontinental-range enemy ballistic missiles by integrating GMD, C2BMC, and various sensors. Other increments are being developed for regional defense to protect U.S. allies and forces deployed to Asia-Pacific, the Middle East, and Europe against short-, medium-, and intermediate-range enemy ballistic missiles. Regional defense is achieved by integrating Aegis BMD, THAAD, C2BMC, Patriot Advanced Capability-3, and allies' weapon systems and

[15]EPAA was announced by the President in 2009, which lays out policy commitments to deliver specific BMDS level capabilities to defend European countries that are members of the North Atlantic Treaty Organization against enemy ballistic missiles.

various sensors.[16] In fiscal year 2016, MDA also took steps to increase its cyber defense capability, expected as part of Increment 4, necessary for ensuring the confidentiality, integrity, and availability of data across the BMDS. The first delivery of this capability is planned for December 2017 and upgrades are to follow with future increment deliveries.

MDA tracks its BMDS level capability goals in systems engineering documents, such as the Master Integration Plan, System Specification Document, and System Description Document. These documents describe how element level upgrades are synchronized to support deliveries of BMDS level capabilities, including the time frames by which elements need to complete development in order to be available for integration and test events. These plans also identify test and assessment needs to confirm capability delivery goals, as well as potential challenges and risks. A Technical Capability Declaration memo is the final step in MDA's process for delivering a BMDS level capability for operational use and is issued by the Director, MDA. The memo describes how the capabilities were assessed and the ability of the system to meet technical specifications under limited set of conditions. It indicates readiness for the warfighter's assessment of the system's operational utility through the Operational Readiness and Acceptance process.

Best Practices for a Sound Business Case

Our prior work has shown that establishing a sound business case is essential to achieving better program outcomes.[17] A sound business case provides decision makers with confidence that the weapon system being acquired is necessary, achievable, and prudent. For example, in 2015, we reported that a sound business case provides credible evidence that (1) the warfighter's needs are valid and can best be met with the chosen concept, and (2) the chosen concept can be developed and produced within existing resources.[18] Key enablers to accomplish this include the following:

[16]Programs that have been transferred to a military service for production, operation, or sustainment such as the Patriot Advanced Capability-3 program are not covered in this assessment.

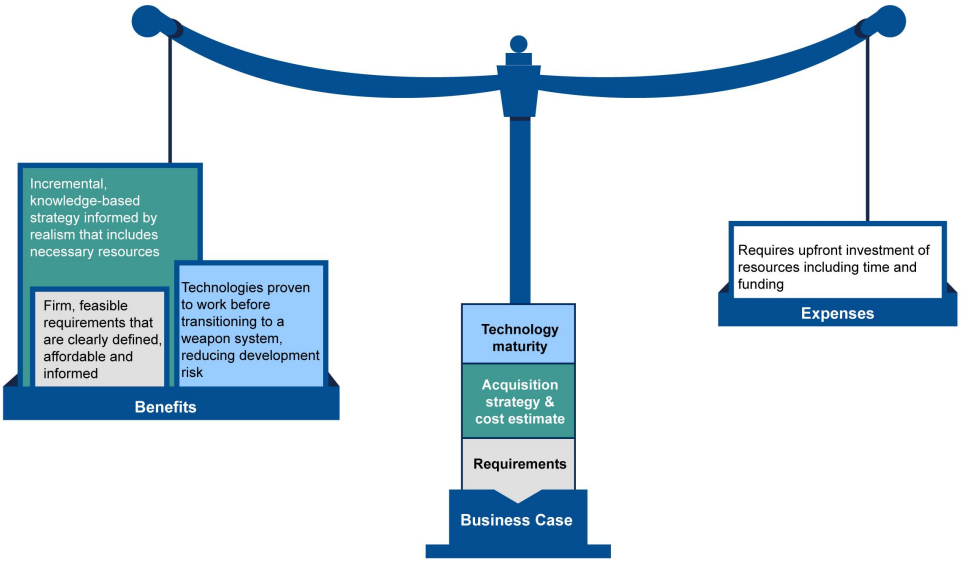
[17]For examples, see GAO-08-1113 and GAO-06-367.

[18]GAO-16-187T.

- defining clear, affordable, and achievable requirements;
- proving technologies before they are included in a weapon system; and
- incorporating knowledge-based acquisition best practices that include realistic cost estimates.

As seen below in figure 2, when all of the elements of a sound business case come together, the result is a business case that expends resources early to minimize risk, thereby increasing the likelihood that the capability will be delivered on time, within budget, and with the necessary performance.

Figure 2: Elements of a Sound Business Case



Source: GAO. | GAO-17-381

A sound business case also represents the most acceptable compromise among competing priorities and, as indicated by our prior work on defense acquisitions, requires patience to take the necessary time up-front to produce well-informed requirements and mature technologies.[19]

[19]See GAO, *Weapon System Requirements: Detailed Systems Engineering Prior to Product Development Positions Programs for Success*, GAO-17-77 (Washington, D.C.: Nov. 17, 2016); and *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, GAO/NSIAD-99-162 (Washington, D.C.: July 30, 1999).

For MDA, the agency is tasked with developing, producing, and fielding new capabilities as rapidly as possible but also expects such capabilities to be affordable and highly reliable, available, and effective. The central challenge of producing a sound business case is finding an acceptable balance between these competing priorities. Finding a balance between resources available (i.e., time and funding) and needed operational attributes (i.e., reliability and effectiveness) is essential as is the buy-in from across the department because DOD components provide varying perspectives because of their unique areas of expertise and experience. Depending on the circumstance, a business case that includes some acquisition risk, such as deferring a flight test or performing concurrent development and production, may be justified. However, the more a business case relies on such measures to meet critical program objectives, the more risk is added to the program, increasing the likelihood the program will fail to meet those objectives and sustain support from within the department.

MDA Made Progress in Fiscal Year 2016 Conducting Tests and Delivering Assets and BMDS level Capabilities but It Did Not Meet Its Planned Goals

MDA conducted several key tests and delivered assets and BMDS level capabilities—performance aspects attained by integrating multiple elements to work together—but did not meet its goals as detailed in its fiscal year 2016 baselines. Specifically, MDA conducted 10 flight tests for fiscal year 2016, most notably, its second BMDS operational test; however target and system malfunctions led to retests, cost increases, and schedule changes. In addition, MDA delivered assets that increase the warfighter's ability to defend against incoming enemy ballistic missiles. While MDA did not meet its asset delivery goals, it took positive steps to address some of the key causes for not doing so, including improving parts quality issues and in certain cases taking steps to reduce concurrency. MDA delivered a total of five BMDS level capabilities, but according to DOT&E and BMDS OTA assessments, testing was insufficient and the capabilities, as delivered, do not likely provide the robust capability as planned. MDA is continuing work on its future increments for regional and homeland defense, but ongoing technical, schedule and funding challenges also place some of these capabilities at risk.

MDA Conducted Most of Its Planned Flight Tests for Fiscal Year 2016, but Target and System Malfunctions Led to Retests, Cost Increases, and Schedule Changes

MDA conducted a total of 10 flight tests in fiscal year 2016, three of the four that it planned to conduct and seven others that were delayed from a prior fiscal year, retests, or tests that were added to address system or target malfunctions. Specifically, MDA conducted seven non-intercept tests to evaluate various capabilities for Aegis BMD, Aegis Ashore, and GMD and its second BMDS operational test, which demonstrated regional defense capabilities and supported the EPAA Phase 2 declaration in December 2015. Table 3 provides details for all flight tests in fiscal year 2016. For more details on each element's testing, see appendixes II-IX.

Table 3: Missile Defense Agency's (MDA) Fiscal Year 2016 Flight Tests, Status, and Description[a]

Number	Planned test's name	Flight test type	Conducted (Yes or no)	Status and description
1	GM CTV-02+	Non-intercept	Yes	**Met Objectives.** Non-intercept test to evaluate Ground-based Midcourse Defense's (GMD) Capability Enhancement (CE)-II interceptor's alternate divert thrusters. A kill vehicle electrical component failed which prevented one of the thrusters from working for a segment of the test.
2	FTX-21	Non-intercept	Yes	**Met Objectives**. Non-intercept test to demonstrate an Aegis Ballistic Missile Defense's 5.0 (BMD) ship's ability to detect and track a medium-range threat.
3	SCD CTV-02	Non-intercept	Yes	**Met Objectives.** Non-intercept test of Aegis BMD's SM-3 Block IIA interceptor.
4	SFTM-01	Intercept	No	**Delayed to fiscal year 2017.** First of six intercept tests to support the production decision for Aegis BMD's SM-3 Block IIA interceptor. This test was successfully conducted the second quarter of fiscal year 2017.

Number	Other test's name	Flight test type	Conducted (Yes or no)	Status and description
5	AA CTV-02	Non-intercept	Yes	**New test – Met Objectives.** Non-intercept test to verify the performance of the Aegis BMD's Standard Missile (SM)-3 Block IB Threat Upgrade (TU) interceptor from the Aegis Ashore site prior to its use in FTO-02 E1a.
6	FTO-02 E1a	Intercept	Yes	**Retest – Met Objectives**. Ballistic Missile Defense System (BMDS) operational test using Aegis Ashore and supporting elements to demonstrate capabilities for the European Phased Adaptive Approach (EPAA) Phase 2 declaration in December 2015. The initial attempt in fiscal year 2015 failed after a new intermediate-range target malfunctioned.

Number	Other test's name	Flight test type	Conducted (Yes or no)	Status and description
7	FTO-02 E2	Intercept	Yes	**Delayed from Prior Fiscal Year - Target Malfunction.** BMDS operational test to demonstrate regional defense capabilities. The short- range target's parachute malfunctioned necessitating a retest, which was successful.
8	FTO-02 E2a	Intercept	Yes	**Retest – Met Objectives.** BMDS operational test to demonstrate regional defense capabilities. Aegis BMD's SM-2 Block IIIA interceptor engaged a cruise missile, but the SM-3 Block IB TU interceptor experienced an anomaly and failed to intercept a medium-range target. THAAD intercepted a short-range target and Aegis BMD's missed target, demonstrating a layered regional defense.
9	FTT-18	Intercept	No	**Delayed from Fiscal Year 2015 – Delayed to Fiscal Year 2017.** Intercept test to demonstrate THAAD's capability against an intermediate-range threat. This test was delayed from fiscal year 2015 to accommodate the retest of the BMDS operational tests.
10	SM CTV-01	Non-intercept	Yes	**New test– System Malfunction.** Non-intercept test to demonstrate the performance of design modifications to Aegis BMD's SM-3 Block IB TU third-stage rocket motor (TSRM) nozzle in support the production decision. System failed during the initial stage of the test.
11	SM CTV-01a	Non-intercept	Yes	**Retest – Met Objectives.** Non-intercept test to demonstrate the performance of design modifications to Aegis BMD's SM-3 Block IB TU TSRM nozzle in support the production decision.
12	SM CTV-02	Non-intercept	Yes	**New test – Met Objectives**. Non-intercept test to demonstrate the performance of design modifications to Aegis BMD's SM-3 Block IB TU TSRM nozzle in support the production decision.

Source: GAO analysis of MDA data. | GAO-17-381

[a]Our methodology for this assessment only includes MDA-led and funded tests, so other tests that MDA participated in fiscal year 2016, such as those internationally or for Patriot, are not included in the table above or analysis included herein.

Most of the tests MDA conducted in fiscal year 2016 were either tests delayed from a prior fiscal year, retests, or new tests MDA added to address system or target malfunctions, some of which had significant cost and schedule impacts. For example, four new tests were added specifically to evaluate Aegis BMD system performance, one of which experienced a system failure, and required a retest. The first event of MDA's second major BMDS operational test—FTO-02 E1—included a new intermediate-range target which malfunctioned due to a safety switch that did not indicate, as designed, that it had safely cleared the aircraft once it was launched. The malfunction prevented the target from executing sequential steps and flying as intended and therefore the test

had to be repeated.[20] We previously recommended that MDA fly each new target in a non-intercept test to verify its performance and reduce risks prior to its use in an intercept test, but it has not implemented this recommendation.[21] Consequently, costs for this first event of the BMDS operational test doubled, increasing from $96 million to $192 million. Despite the costly impacts from the use of a new target, MDA plans to use a new intercontinental-range target during an upcoming GMD intercept test—FTG-15—that is designed to demonstrate the CE-II Block I interceptor's and its second generation booster's performance in support of the goal to field 44 interceptors by the end of 2017. Due to the addition of tests delayed from prior fiscal years, retests, and new tests, MDA had to reduce conflicts in its test schedule by delaying multiple, and in at least one instance critical, tests. For example, to accommodate the retest of both events for the BMDS operational test, THAAD's first flight test to demonstrate its capability against an intermediate-range threat has previously been delayed and is now delayed to at least the third quarter of fiscal year 2017, although it is a critical test for the Army which has had a THAAD battery deployed to defend against this threat range since 2013.[22]

MDA Delivered Some Assets and Took Positive Steps to Resolve Key Causes That Have Inhibited Progress Toward Meeting Its Fiscal Year Goals

MDA delivered various assets in fiscal year 2016 to increase the warfighter's ability to defend against enemy ballistic missile attacks; however, it did not meet its asset and BMDS level capability delivery goals. For example, MDA delivered the Aegis Ashore site in Romania in December 2015 to provide increased protection of Europe. Also, MDA delivered the majority of its planned Aegis BMD interceptors, some of its planned THAAD interceptors, and made upgrades to existing GMD interceptors. Table 4 below highlights the assets MDA delivered in fiscal year 2016. For more details on each element's assets, see appendixes II-IX.

[20]We previously reported this target failure in GAO, *Missile Defense: Ballistic Missile Defense System Testing Delays Affect Delivery of Capabilities,* GAO-16-339R (Washington, D.C.: Apr. 28, 2016).

[21]GAO, *Missile Defense: Opportunity to Refocus on Strengthening Acquisition Management,* GAO-13-432 (Washington, D.C.: Apr. 26, 2013).

[22]We previously reported the delays to this test in GAO-16-339R.

Table 4: Missile Defense Agency's (MDA) Asset Delivery Goals and Status for Fiscal Year 2016

Ballistic Missile Defense asset	Delivery goal	Delivered
Aegis Ballistic Missile Defense(BMD)[a] - Aegis Ashore Site (Romania)	1	1
Aegis Ballistic Missile Defense(BMD)[a] - Standard Missile-3 Block IB Interceptors	47	33
Ground-based Midcourse Defense (GMD) Capability Enhancement-II Interceptors	8	6[b]
Terminal High Altitude Area Defense (THAAD) Interceptors	48	21
Total	**104**	**61**

Source: GAO analysis of MDA data. | GAO-17-381

[a]MDA delivered the first Aegis BMD SM-3 Block IIA interceptor for testing in fiscal year 2017.

[b]The GMD interceptors were not new deliveries; rather, upgrades made to existing interceptors.

In 2016, MDA took positive steps to address two key causes that have hampered progress in meeting asset delivery goals in prior fiscal years—parts quality issues and concurrency (i.e., overlap between development, testing, and production).

- **Parts Quality Issues:** We have previously found that parts quality issues can lead to rework, cost increases, schedule delays, reduced system reliability and availability, and in some cases, a complete halt in a program.[23] In fiscal year 2016, because of ongoing parts quality issues, THAAD's contractor stopped production of interceptors and other MDA elements were also affected by parts quality issues. It is MDA's responsibility, as the government entity, to provide oversight of parts quality and ensure procedures are in place and followed. Thus, we previously recommended that MDA track such issues and the effectiveness of any corrective measures.[24] While it had not implemented this recommendation, in April 2016, MDA issued a policy memo to emphasize parts quality assurance with various requirements for doing so, including onsite verification assessments at subcontractor facilities.[25]

[23]GAO, *Space and Missile Defense Acquisitions: Periodic Assessment Needed to Correct Parts Quality Problems in Major Programs,* GAO-11-404 (Washington, D.C.: June 24, 2011).

[24]GAO-11-404.

[25]Missile Defense Agency Policy Memo Number 86, "Parts, Materials, and Processes Requirements Verification, (Apr. 7, 2016).

- **Concurrency:** For many years we have reported on MDA's use of a highly concurrent acquisition approach. MDA's use of concurrency, coupled with its aggressive testing schedule, has often left the agency in the position of either disrupting or pushing forward with production when developmental or testing problems occur.[26] Despite our recommendation to the contrary, MDA has generally opted to continue production prior to validating performance through testing to enable it to rapidly deliver assets to the warfighter, albeit with higher risks of needing retrofits or fixes to address later address identified problems.[27] However, in fiscal year 2016, MDA added new tests specifically to evaluate design changes to the third-stage rocket motor nozzle of Aegis BMD's SM-3 Block IB interceptor before inserting it into the production line. Also, DOD previously postponed the full-rate production decision for this interceptor until these tests were completed. Both actions of adding tests to evaluate the design changes and postponing the full-rate production decision align with prior recommendations we have made.[28] These actions reduced the risk of additional cost impacts, schedule delays, and production disruptions and provided a more robust basis for the production decision.

In taking these steps, MDA has lessened some of the risks for its asset deliveries. Also, it has reduced risks for the overall operational performance of the BMDS because all of the elements have complex interactions and interdependencies so not delivering or delivering problematic or underperforming assets could affect multiple elements.

BMDS Level Capabilities Were Delivered for Regional Defense, but Do Not Provide Robust Defense as Planned

In fiscal year 2016, MDA delivered a total of five BMDS level capabilities for regional defense, three of which are specifically designed for the

[26]As reported in *Missile Defense: Opportunity Exists to Strengthen Acquisitions by Reducing Concurrency,* GAO-12-486 (Washington, D.C.: Apr. 20, 2012), GAO-13-432, and *Missile Defense: Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities,* GAO-15-345 (Washington, D.C.: May 6, 2015).

[27]*Defense Acquisitions: Production and Fielding of Missile Defense Components Continue with Less Testing and Validation Than Planned*, GAO-09-338 (Washington, D.C.: March 13, 2009).

[28]GAO-15-345 and *Missile Defense: Mixed Progress in Achieving Acquisition Goals and Improving Accountability*, GAO-14-351 (Washington, D.C.: Apr. 1, 2014).

EPAA Phase 2. EPAA Phase 2 provides regional defense against medium-range ballistic missile threats and builds on the initial phase delivered in December 2011. Table 5 provides a description of regional defense capabilities and identifies those for EPAA Phase 2 specifically, and those that were delivered for its larger regional ballistic missile defense effort.

Table 5: Missile Defense Agency's (MDA) Fiscal Year 2016 Ballistic Missile Defense System (BMDS) Level Capabilities for Regional Defense

Number	BMDS level capability description	Goal for European Phased Adaptive Approach Phase 2	Capability delivered for regional BMDS
1	Integration of Aegis Ashore into the BMDS in Europe.	Yes	Yes
2	Launch on Remote, which allows Aegis ships or Aegis Ashore to launch Standard Missile -3 IB interceptors based on cues from radars located closer to the threat launch site, via the Command, Control, Battle Management and Communications (C2BMC).	Yes	Yes
3	BMD System-Track, which allows C2BMC to generate threat tracks (i.e., paths) based on data from one or more sensors and post them onto DOD's communication network used by other elements, like Aegis BMD.	Yes	Yes
4	Debris mitigation, which improves BMDS performance in the presence of debris from threat missile separation, intercepted threat ballistic missiles, and waste from missile fuel.	No	Yes
5	Radar Cross-Area of Responsibility, which allows specific radars in Europe and the Middle East to collaborate and improve the tracking of threat ballistic missiles.	No	Yes

Source: GAO analysis of MDA data. | GAO-17-381

Although MDA delivered regional capabilities as scheduled, DOT&E concluded that testing was insufficient and the capabilities, as delivered, likely do not provide robust defense against medium-range ballistic missiles as planned. First, all four tests used to support the delivery of these capabilities included limitations that deviated from how the warfighter would use them under realistic conditions. While this is unavoidable in some cases due to range limitations, safety concerns and cost considerations, in other cases, testing limitations were discovered during the test. Second, some of the models and simulations—which are needed to assess the integrated BMDS in scenarios that cannot be executed during flight testing—were unaccredited and still remain as such.[29] According to the BMDS OTA officials—the agency responsible for

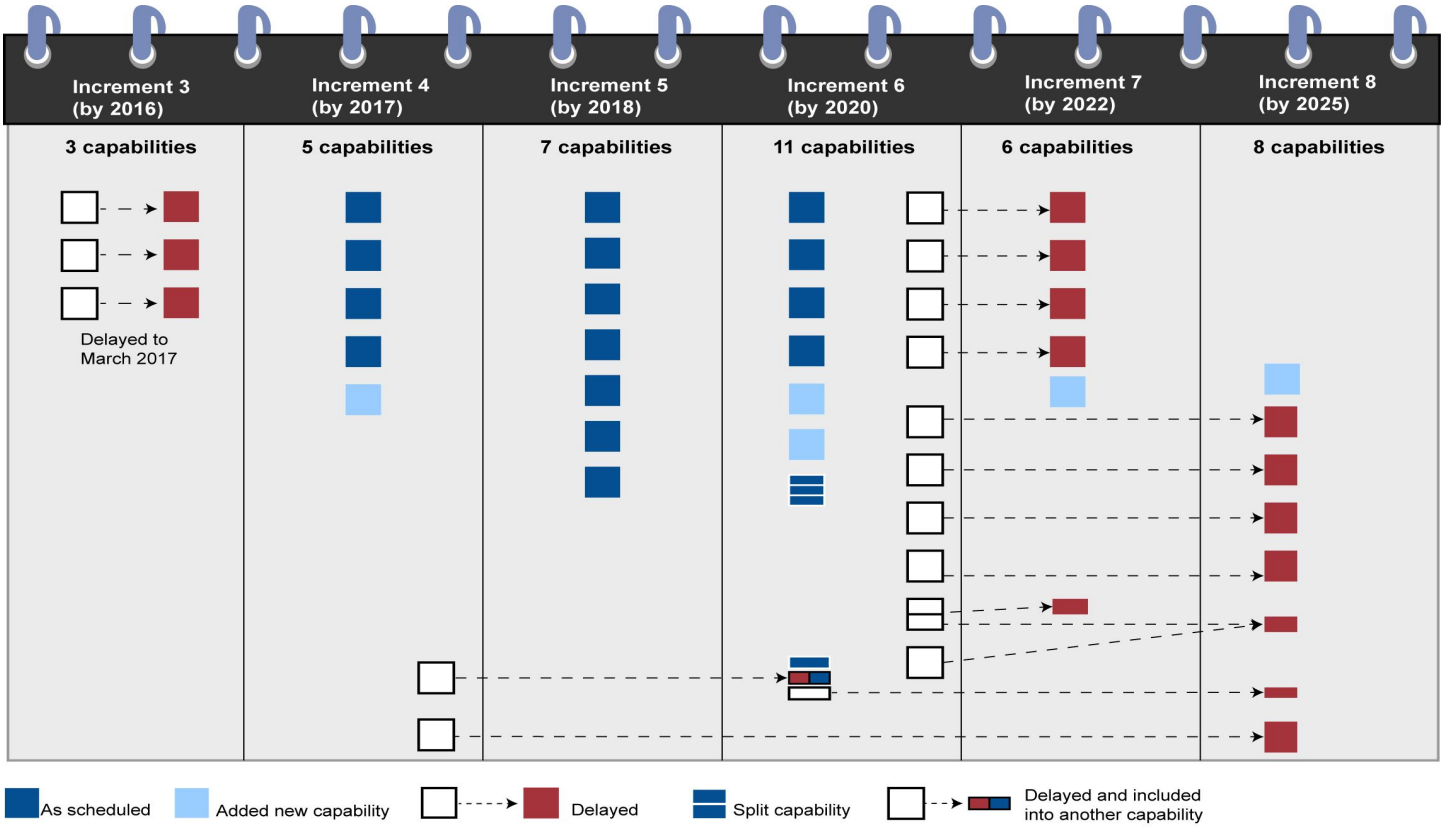
[29]A model is a representation of an actual system. A simulation is a method for implementing a model, such as virtual experiments for the purpose of understanding the system's behavior under selected conditions.

accrediting the models—having just one unaccredited model in the test reduces confidence in the results of the entire assessment. Last, in addition to the testing limitations, the tests revealed performance issues that could lead to missed or multiple attempts to defeat a single threat. For example, there were difficulties tracking targets, discriminating the lethal object in the targets, and mitigating interference from any debris. Also, there were integration challenges across the various elements involved in the tests. For example, during some tests, there were difficulties processing data between Aegis BMD and C2BMC. According to our analysis, all of these issues combined, significantly lower the overall performance of the EPAA Phase 2 capabilities and could be exacerbated as the complexity of ballistic missile attacks increase.

Additional BMDS Level Capabilities Were Delayed and More Are at Risk of Delays

Despite delivering EPAA Phase 2 in December 2015, ongoing technical and funding issues have led to recurring delays and other changes in MDA's delivery plan. Figure 3 shows changes to MDA's capability delivery plan implemented in fiscal year 2016, including the addition of five new capabilities, and 17 delays—three of which were split off from larger capabilities.

Figure 3: Deviations in Missile Defense Agency's (MDA) Capability Delivery Plan by Increment[a]



Source: GAO analysis of MDA capability delivery plans. | GAO-17-381

[a]Increments are composed of Ballistic Missile Defense System-level capabilities to improve the integrated system performance.

Examples of deviations in the fiscal year 2016 Capability Delivery Plan include the following:

- Automated engagement command and management at the BMDS level was delayed from Increment 6 in December 2020 to Increment 8 in December 2025. Previously, this capability was scheduled for December 2015, and has been delayed multiple times, in part due to C2BMC technical and funding challenges, for a total of a 10-year slip. This capability is important because it represents a significant increase in BMDS integration by centralizing and automating command decisions across the BMDS, to improve coordination and deconfliction of engagements by multiple BMD shooters. As such, it is a key upgrade for improving performance against ballistic missile raid attacks. According to DOT&E, the BMDS is still not truly integrated,

but rather a federated system where elements make engagement decisions individually.

- Completion of Engage on Remote (EOR) was also delayed again in MDA's 2016 capability delivery plan. Previously, it was planned for full delivery in December 2018 as the sole EPAA Phase 3 capability. However, in fiscal year 2015, it was split to deliver some content in December 2020, largely due to technical challenges with C2BMC. In fiscal year 2016, it was further delayed from Increment 6 in December 2020 to Increment 7 in December 2022, after integration and delivery of a new radar was added to Increment 6, according to MDA officials.
- Three BMDS level capabilities designed to improve the Homeland Defense architecture in Increment 3 were delayed from December 2016 to March 2017.[30] They were also delayed previously from September to December 2016. While our assessment of these efforts found that GMD had development delays for some software upgrades leading up to an assessment and integration activities, MDA officials told us that the delay was driven by additional time needed to analyze testing results.

In addition to the known changes to MDA's BMDS level Capability Delivery Plan in fiscal year 2016, our assessment of MDA's system engineering and element level acquisition management documents indicate that additional BMDS level capabilities are at an increased risk for delays. Potential for these delays are the result of likely technical challenges encountered during the synchronization of individual element level efforts with the BMDS level schedule. For example:

- For Increment 4 (December 2017), three out of five capabilities could be reduced or delayed, as constituent software upgrades for GMD and certain sensors, among other elements are at risk to be delivered after the beginning of associated integration activities. This, in turn, could reduce time to resolve any integration issues, should they be discovered. Moreover, according to MDA documentation, the current schedule for this increment already leaves little margin to address any major integration challenges. In addition, MDA has added BMDS level Cyber Defense capability as part of this increment to be delivered in December 2017. However, MDA is still developing a comprehensive cyber-defense strategy to manage this effort and a detailed test plan.

[30]According to MDA officials, Improvements to the Homeland Defense architecture were delivered and approved by the Director, MDA with the Near Term Discrimination Technical Capability Declaration on March 23, 2017.

This plan has been delayed multiple times—most recently from its January 2017 release. These delays, according to DOT&E officials, are likely to reduce the scope of the first Cyber Defense test, scheduled to begin in October 2017. Because MDA is still developing its plans, we were unable to assess the extent to which this capability will be delivered on time and provide the necessary protections.

- For Increment 5 (December 2018) which includes EPAA Phase 3, six out of seven capabilities could be reduced or delayed, as constituent upgrades for C2BMC, Aegis BMD, a sensor and THAAD face delays. This will compress the integration schedule for these six planned capabilities including EOR—the sole EPAA Phase 3 capability— and reduce the time to address any integration issues, should they be discovered. Additionally, other element level delays have already impacted and could further impact EOR.

MDA's Testing Schedule Remains Aggressive and Associated Costs Lack Transparency

MDA's integrated test schedule—its test baseline, commonly referred to as the Integrated Master Test Plan (IMTP)—continues to be aggressive despite its increasing pace and complexity and its lack of traceability raises questions about what progress has actually been achieved. MDA's individual test schedules—an execution schedule for a specific test within the test baseline—may be unreliable and not only deviate from scheduling best practices, but MDA's scheduling policies as well. Finally, it was difficult to determine the costs associated with testing due to consistency and transparency issues, including the lack of or unclear documentation, inconsistent inputs and outputs, and lack of traceability.

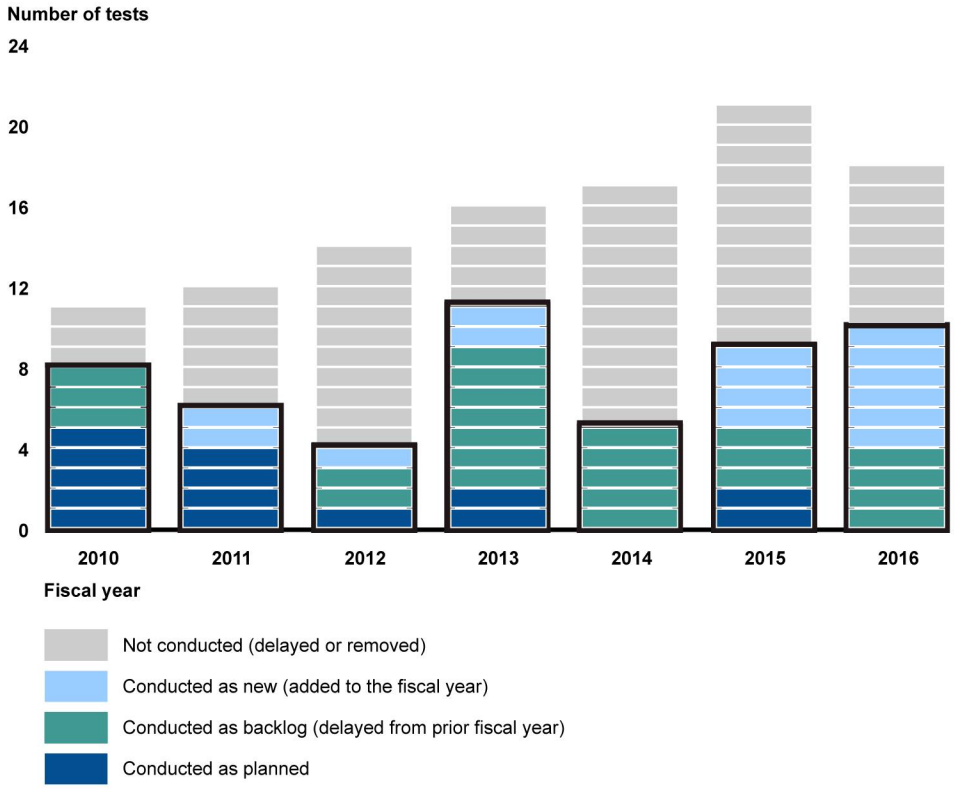
MDA's Integrated Test Schedule Remains Aggressive and has Limited Traceability

As we have previously found, MDA's integrated test schedule is aggressive, in that it includes too many tests and little to no margin between the tests reducing MDA's ability to complete it as planned and consequently, the ability to track progress or costs.[31] Since fiscal year 2010, MDA's test schedule has, on average, included 16 flight tests each

[31]*Missile Defense: Actions Needed to Improve Transparency and Accountability,* GAO-11-372 (Washington, D.C.: Mar. 24, 2011); GAO-15-345; and GAO-16-339R.

fiscal year and it has, on average, executed 8, with 4 and 11 being the least and most, respectively. Thus, when setbacks occur, such as system or target malfunctions, the margin between tests has eroded MDA's flexibility to make schedule adjustments. Consequently, MDA has yet to conduct all of its planned tests for a fiscal year, which has created a backlog of tests not conducted. MDA relieves pressure in the schedule by delaying and removing tests instead of including sufficient schedule margin to ensure executability, as we previously recommended.[32] As a result, since fiscal year 2012, the tests that it has conducted have primarily been either those backlogged from prior fiscal years or new tests to address system, target, or other testing setbacks, as shown in figure 4.

Figure 4: Missile Defense Agency's (MDA) Flight Test Execution for the Ballistic Missile Defense System for Fiscal Years 2010-2016



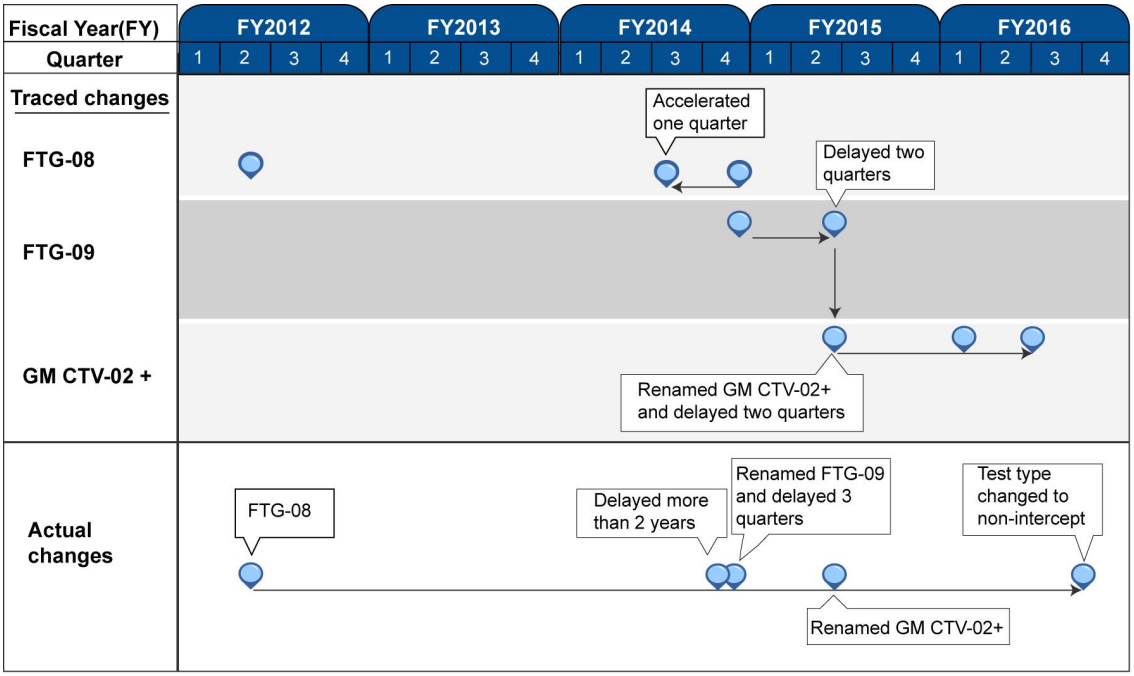
Source: GAO analysis of MDA data. | GAO-17-381

[32]GAO-11-372.

Along with the growing backlog, we have found that MDA is increasing the complexity and pace of flight testing, as 77 percent are planned to be intercept tests through fiscal year 2020 compared to 51 percent to date. In addition, both events for MDA's third and largest BMDS operational flight test—FTO-03—are scheduled during this time frame and there are multiple tests that will use new targets, both of which increase the risks to the execution of all of these tests. For MDA to achieve its planned testing through 2020, the tests must be on time and successful; otherwise, it may need to make trade-offs among priorities and delay or remove tests. When MDA does not conduct tests as planned, it defers the demonstration and confirmation of system and capability performance which leaves the warfighter with the decision to either not use the system or capability or use it with an increased risk that it may not perform as intended.

In addition to the growing backlog and increasing pace and complexity, MDA's integrated test schedule does not clearly trace schedule changes—a key aspect of a baseline—thereby limiting insight into what is happening with each test. MDA updates its integrated test schedule at least once annually with new tests that have been added, retests, and tests that have been removed, including any movement in fiscal year quarters for execution dates. However, these updates are limited to those from the prior fiscal year's version of the integrated test schedule, so any changes prior to that version are not captured. As an example of changes to a specific test event, the integrated test schedule for fiscal year 2016 shows a THAAD test—FTT-16—as accelerating a quarter in fiscal year 2020; however, this test was originally planned to be executed in fiscal year 2013, a seven year delay. Also, due to developmental and testing setbacks, a GMD's test objectives were modified which resulted in its name being changed three times, it was modified from an intercept to a non-intercept, and it was delayed a total of four years, from fiscal year 2012 to 2016, but the integrated test schedule does not clearly trace these changes, as shown in figure 5.

Figure 5: Traced Versus Actual Changes to One of Missile Defense Agency's Flight Test for Ground-based Midcourse Defense (GMD)



FTG — Flight test Ground-based Midcourse Defense

GM CTV-02 + — Ground-based Midcourse Defense Controlled Test Vehicle

Represents planned execution date

Source: GAO analysis of MDA data. | GAO-17-381

The lack of traceability in MDA's integrated test schedule makes it difficult not only to determine what is happening with a test, but also with its testing progress as a whole, including what and when requirements were originally planned to be met and which ones have been met, when they are met, and with what test. For example, MDA conducted a THAAD test—FTT-11—in December 2009 to demonstrate an advanced algorithm to meet the Army's acceptance requirements, but the target failed, necessitating a retest. The retest was on the integrated test schedule several times, and finally its objectives were combined with the BMDS operational test conducted in fiscal year 2016, 6 years later. Over that period, THAAD made hardware and software adjustments to its interceptors, launchers, and other support equipment. As such, it is unclear which of the five THAAD battery equipment sets and over 100 interceptors that have been delivered to the warfighter before the BMDS operational test, if any, have met the Army's acceptance requirements. According to GAO's best practices for scheduling, a baseline should

include the original dates, current dates, and associated changes to accurately gauge progress.[33] However, the lack of traceability in MDA's integrated test schedule, changes to tests, and overall testing progress cannot be discerned without analyzing and comparing multiple documents across several fiscal years and preparing a detailed crosswalk of the information. Without an adjustment to how MDA traces and reports changes to the tests in its integrated test schedule, which could be accomplished with a detailed crosswalk, information critical for understanding its progress will remain obscured.

MDA's Individual Test Schedules May Be Unreliable and Do Not Meet the Agency's Scheduling Standards

MDA's individual test schedules may not reliably forecast execution dates, in part due to deficiencies in, and deviations from, its scheduling policies. A schedule is a critical management tool because it defines what activities need to be completed, the duration of the activities, and the completion date for the activities. The schedule also serves as the basis for developing a time-phased budget to pay for the activities. We assessed MDA's scheduling policies and found that they generally align, but do not fully meet the four characteristics outlined in GAO's best practices guide for scheduling.[34] For example, MDA's scheduling policies set forth requirements to capture and sequence all activities, ensure traceability, and maintain a schedule baseline. Figure 6 details our assessment.

[33] GAO-16-89G.

[34] GAO-16-89G.

Figure 6: Assessment of Missile Defense Agency's (MDA) Scheduling Policies against GAO's Identified Best Practices for Scheduling

Best Practice Characteristic and Description	Assessment	
Comprehensive		
• Captures all schedule activities.	Substantially met	Partially met
• Assigns resources to all activities.	Not met	
• Establishes durations for all activities.	Partially met	
Well-constructed		
• Sequences all activities.	Met	Substantially met
• Confirms that the critical path is valid.	Partially met	
• Ensures reasonable total float.	Met	
Accurate		
• Ensures traceability, horizontally and vertically.	Met	Substantially met
• Includes a risk analysis to establish priorities and contingencies.	Minimally met	
Credible		
• Updates made using actual progress and logic.	Partially met	Substantially met
• Maintains a baseline schedule.	Met	

Legend

Not Met	MDA provided no evidence that satisfies any of the criterion.
Minimally Met	MDA provided evidence that satisfies a small portion of the criterion.
Partially Met	MDA provided evidence that satisfies about half of the criterion.
Substantially Met	MDA provided evidence that satisfies a large portion of the criterion.
Met	MDA provided complete evidence that satisfies the entire criterion.

Source: GAO assessment of MDA scheduling policies. | GAO-17-381

While MDA's scheduling policies generally align with the best practices we have identified, there are a number of deficiencies, such as a lack of a mechanism to ensure that the schedule aligns with the budget, no requirement to assign resources to schedules, and unclear guidance on risk analysis. Because best practices are interrelated, deficiencies in one best practice can cause deficiencies in others. We identified deficiencies in each of MDA's scheduling policies, but the most notable were related to the best practices attributes of comprehensive and credible:

Comprehensive. To be comprehensive, a schedule should include (1) all activities necessary to accomplish the objectives as defined in the work breakdown structure (WBS), (2) the resources needed for doing so, and (3) realistic time frames for each activity. MDA's scheduling policies lack the following:

- **No requirement for schedule work breakdown structure (WBS) to ensure alignment with budget**. MDA's policies that we reviewed require schedule activities to align with budget documentation, in accordance with best practices, but they do not detail how to ensure this alignment. According to best practices, there should be a schedule WBS that traces to each activity and aligns with the cost WBS.[35] A WBS defines, in detail, what work is necessary to accomplish a project's objectives, including the activities the government and contractors are to perform. We found that the activities included in one of MDA's flight test schedules did not align with its cost estimate. Without a schedule WBS, alignment of the schedule and budget cannot be ensured, which could prevent MDA's, Congress's, and oversight officials' ability to pinpoint the cost effects of schedule adjustments or slippages.
- **Resources not required to be assigned to individual test schedules.** According to best practices, a schedule should reflect the resources (e.g., labor, materials, travel, facilities, equipment, and the like) needed to do the work, whether the resources will be available when needed, and any constraints on funding or time.[36] A test schedule without assigned resources implies an unlimited amount and availability of such. MDA officials stated that information on schedule driven resource needs is shared at a high level as part of MDA's budget development process; however, they did not specify what information is shared, with whom, or how.

Credible. A schedule is credible if it is horizontally traceable—reflects the order of events to achieve outcomes—and vertically traceable—activities map to one another—and risk analysis identifies high-priority risks and is used to establish a confidence level for meeting the completion date. MDA's scheduling policies are unclear about risk analysis.

- **Unclear guidance on when and how to conduct schedule risk analysis.** MDA's scheduling policies that we reviewed indicate that a schedule risk analysis should be conducted upon request by a manager, but it does not specify under what conditions a manager should request one, who is responsible for conducting it, or how it is to be conducted. According to best practices, programs should include the results of a schedule risk analysis in constructing an executable baseline schedule because it helps determine the level of confidence

[35]GAO-16-89G.

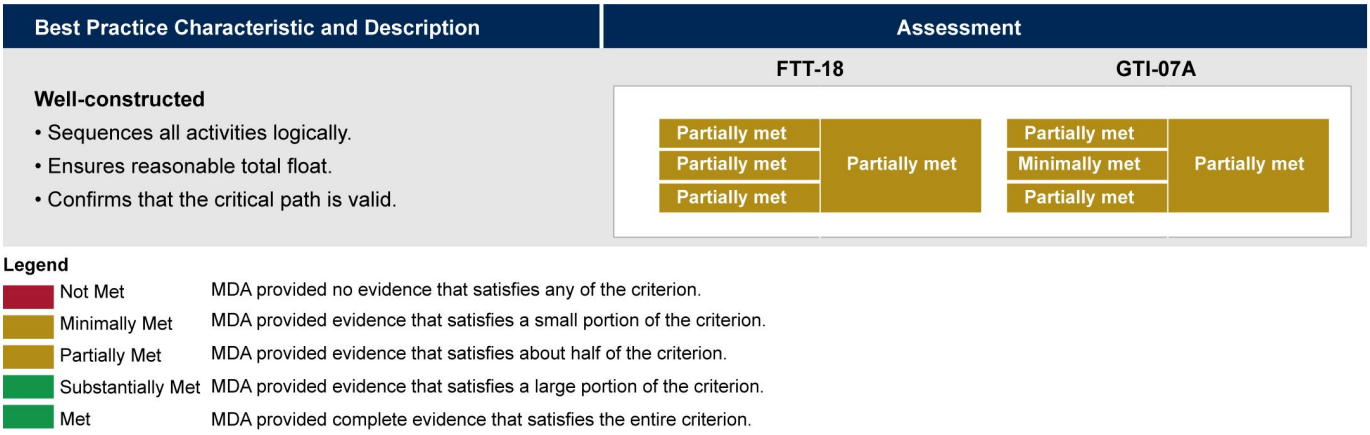
[36]GAO-16-89G.

in meeting the execution date by identifying risks and prioritizing threats and opportunities and any necessary schedule contingency.[37] MDA officials agreed that its policies are unclear and that they will consider adjustments during the next revision.

To evaluate MDA's implementation of its scheduling policies, we assessed the reliability of two individual test schedules—a flight and ground test—and found that they only partially meet best practices and deviate from MDA's scheduling standards. Specifically, if the well-constructed characteristic is not met then the schedule cannot be considered reliable because the characteristic encompasses the foundational best practices that a schedule must meet. A well-constructed schedule is fully sequenced, has a critical path, and calculates reasonable total float. However, both test schedules were missing key information to provide a reliable timeline and execution date. Figure 7 details our assessment.

[37] GAO-16-89G.

Figure 7: Assessment of Two of Missile Defense Agency's (MDA) Individual Flight Test Schedules Against Attributes of the Well-Constructed Characteristic in GAO's Best Practices Guide for Scheduling



Source: GAO assessment of MDA individual test schedules. | GAO-17-381

Both individual test schedules we assessed:

- Lacked properly sequenced activities due to omitted dependencies or invalid logic relationships between activities. Without clear and complete dependencies and valid logic relationships between activities, the schedule cannot predict the effect that unrealistic deadlines, delayed activities, external events, scope changes, and misallocated resources, among other things, will have on the test's execution date.
- Included an unreasonable amount of total float (i.e., the amount of time an activity can be delayed before it affects the test execution date). A reasonable amount of total float in a schedule allows management to identify activities that could be slipped and resources that could be reallocated to other or higher priority activities to be completed on time.
- Lacked a valid critical path to test execution. Without a valid critical path, those responsible for managing the test cannot provide a timeline or identify what activities, if delayed, will delay the test execution date.

MDA officials acknowledged the shortcomings in both their scheduling policies and individual test schedules. Accordingly, they said that they plan to make adjustments to the scheduling policies during their next planned revision. As for the individual test schedule's deviation from MDA policies, MDA officials indicated that there are efforts underway to develop more detailed, better constructed schedules, but they provided limited details as to what those efforts are, which schedules they apply to,

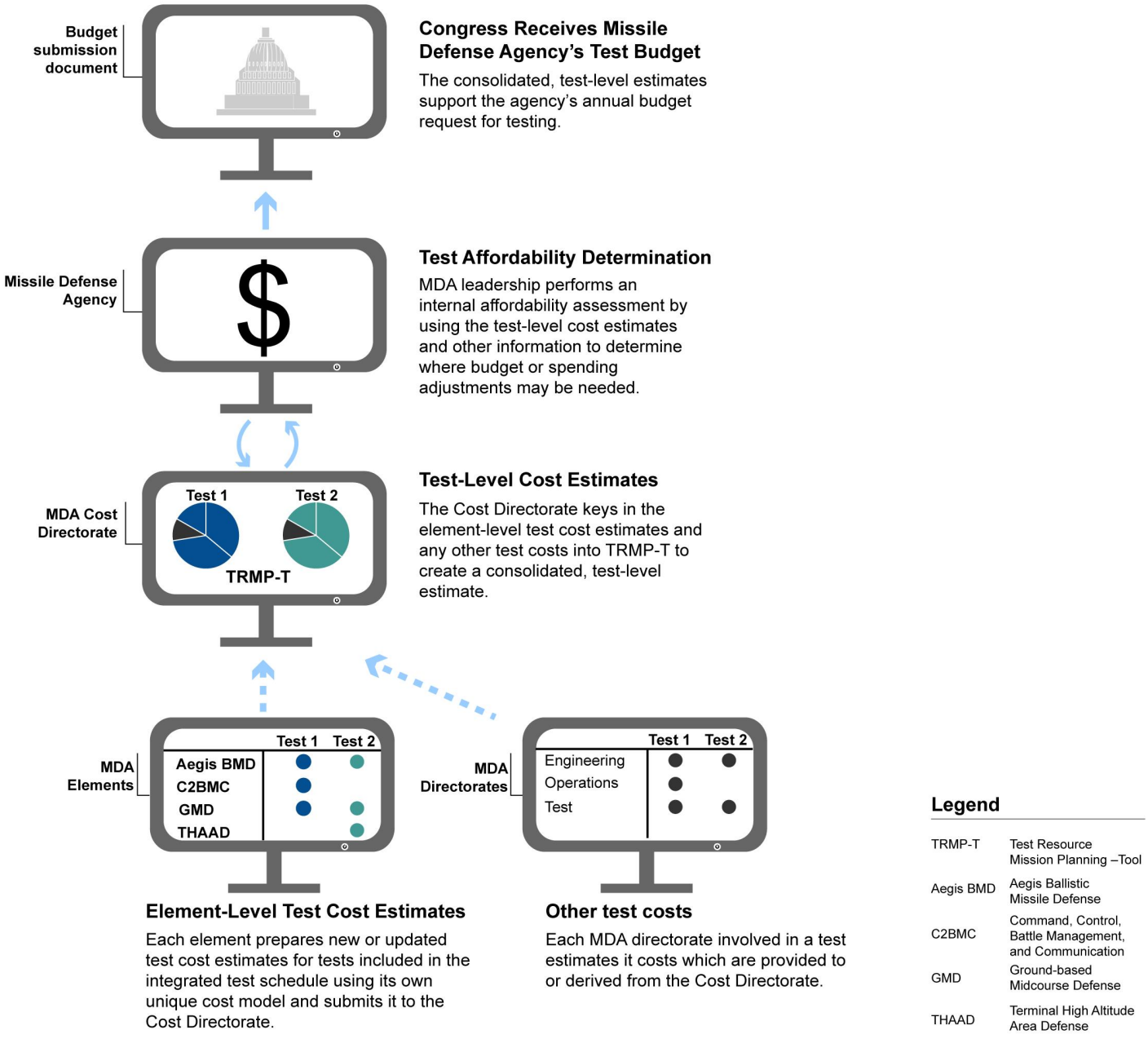
and associated timelines. Until MDA fully aligns it scheduling policies with best practices and ensures that they are consistently implemented, it is likely to continue to create individual test schedules that cannot reliably forecast execution dates, which can impede its management of the integrated test schedule.

MDA's Test Cost Estimates Are Inconsistent and Lack Transparency

MDA requests more than $1 billion in funding each fiscal year for the tests outlined in its integrated test schedule based on internally developed test cost estimates, but our analysis found that these estimates are inconsistent and lack documented traceability. A cost estimate is the summation of individual costs using established methods and valid data. The management of the cost estimate involves continually updating it with actual costs as they become available, revising it to reflect changes, and analyzing differences between the estimated and actual costs.[38] Based on available data and interviews with relevant officials, we found, and MDA confirmed, that it develops cost estimates at two distinct levels, the element and the test. Figure 8 depicts the process MDA uses for determining its testing costs and associated funding need.

[38]GAO-09-3SP.

Figure 8: Missile Defense Agency's (MDA) Process for Determining Total Costs and Funding Needs for Tests Included in Its Integrated Test Schedule



Source: GAO assessment of MDA data. | GAO-17-381

According to our analysis of MDA documentation, confirmed by MDA officials, MDA develops cost estimates at two distinct levels, the element

and the test level. At the element level, an element (e.g., Aegis BMD, GMD, THAAD) creates its respective test estimates, as each has its own baselines, contractors, military service lead (e.g., Army, Navy), and long-established traditions and practices. At the test level, MDA's Cost Directorate uses a classified application—the Test Resource Mission Planning-Tool (TRMP-T)—to consolidate the element level estimates.[39] MDA's Cost Directorate then adds other costs from various directorates into each test level estimate based on that test's design and associated requirements, such as a barge used for transportation or an aircraft used for observation. These other costs have supporting estimates that are either derived from the Cost Directorate, the elements, or other entity within MDA, according to MDA's Cost Directorate officials. This process is used to create test level estimates for all of the tests included in the integrated test schedule. The Cost Directorate then sends the estimates to the elements, various stakeholders, and MDA management for vetting and approval. Finally, MDA performs an affordability review based on the estimated total costs for testing, which can be an iterative process to resolve any misalignments, determine the funding needs, and submit a budget request.

Element Level Estimates for Testing Substantially Met Best Practices for Cost Estimating; Test Level Estimates Did Not

We found that the element level estimates for testing generally align with best practices for cost estimating, while the test level estimates had significant deficiencies, such as lack of or unclear documentation, inconsistent inputs and outputs, and lack of traceability. Best practices include a compilation of characteristics and associated attributes that agencies can use to develop and maintain reliable cost estimates.[40] Developing and maintaining reliable cost estimates ensures agencies request the appropriate amount of funds, when the funds are needed, and for the expressed purpose. Doing so is imperative, because funds provided and spent on one effort mean less are available for other efforts. Figure 9 details our assessment of MDA's element and test level estimates against these best practices.

[39]TRMP-T has other functions, including tracking discrete test objectives and requirements, which are at a classified level, although the test level cost estimates and associated outputs are not classified.

[40]GAO-09-3SP.

Figure 9: Assessment of Missile Defense Agency's (MDA) Element and Test Level Test Cost Estimates Against GAO's Identified Best Practices for Cost Estimating

Best Practice Characteristic and Description	Assessment	
	Element Level Test Estimates	Test Level Estimates
Comprehensive • Includes all life-cycle costs.[a] • Defines program, reflects current schedule, and technically reasonable. • Includes a work breakdown structure that is traceable and ensures costs are not omitted or double-counted. • Documents all ground rules and assumptions.	Not applicable Partially met Partially met Substantially met → Partially met	Not applicable Not met Minimally met Not met → Not met
Well documented • Captures source data, its reliability, and how it was normalized. • Details calculations and estimating methodology. • Includes step-by-step instructions to enable replication. • Describes and consistent with technical baseline. • Contains evidence of view and approval.	Partially met Substantially met Substantially met Partially met Met → Substantially met	Not met Not met Not met Not met Partially met → Not met
Accurate • Results are unbiased--not overly conservative or optimistic. • Adjusted for inflation. • Contains few, if any, minor mistakes. • Updated regularly to show current status. • Variances between planned and actual costs are documented, explained, and reviewed. • Based on historical record of cost and actual experience from comparable programs. • Uses appropriate estimating technical for each cost.	Met Substantially met Substantially met Met Not met Met Substantially met → Substantially met	Not met Partially met Not met Met Not met Partially met Not met → Minimally met
Credible • Includes sensitivity analysis to identify range of possible costs. • Contains risk and uncertainty analysis to quantify risks and effects of changing key cost drivers. • Crosschecks major cost elements for similarity of results. • Includes an independent cost estimate.	Met Met Partially met Partially met → Substantially met	Not met Not met Not met Not met → Not met

Legend

Not Met	MDA provided no evidence that satisfies any of the criterion.
Minimally Met	MDA provided evidence that satisfies a small portion of the criterion.
Partially Met	MDA provided evidence that satisfies about half of the criterion.
Substantially Met	MDA provided evidence that satisfies a large portion of the criterion.
Met	MDA provided complete evidence that satisfies the entire criterion.

Source: GAO assessment of MDA individual test schedules. | GAO-17-381

[a]This best practice was not evaluated as the review was focused on test costs only.

Although MDA's element level estimates generally align with best practices, there are some areas for improvement and its test level estimates have significant deficiencies. The most notable best practices deficiencies in the element and test level estimates related to the attributes of comprehensive, well-documented, and accurate as follows:

Comprehensive. An estimate is comprehensive if it includes all costs using a WBS for a consistent and visible framework, ensuring that costs are neither omitted nor double counted and that all cost-influencing ground rules and assumptions are detailed.

- **A common test WBS exists; but it is not being used**. We found that MDA has a common test WBS intended to capture costs comprehensively and consistently across the elements; however, none of the elements use it for estimating test costs. Currently, each element uses its own unique, albeit sometimes similar WBS. Use of a common WBS enables data sharing and aggregation, while different WBSs may lead to different data collection and cost estimates, with varying levels of detail. Also, without a common WBS, it may hinder an agency's ability to track resource allocations and actual amounts spent.

Well-Documented. A well-documented estimate includes and traces to source data, clearly detailed calculations and results, and explanations of why particular methods and references were chosen.

- **Limited source data descriptions for element level estimates for tests.** We found instances where no narrative was provided to describe the use or modification of source data. Specifically, MDA uses a number of methodologies to create element level estimates and among these is an analogy, which involves using a prior test's estimate as the basis for a new test's estimate. When using an analogy, though, it is important to make adjustments to the new estimate for unique aspects of the prior test's estimate that may not be applicable and to document this information. For example, if the prior test encountered delays and associated cost increases, it should be adjusted or removed when serving as the basis for a new test's cost estimate. However, we found that MDA generally did not make any adjustments to a new test's estimate when using an analogy. Without adjustments, the cost estimate could be under- or over-estimated; thereby creating instances of shortages or overages.
- **No documented traceability to the source data for test level estimates**. We found that some of the data between the element and

test level estimates did not align. However, according to MDA Cost Directorate officials, the costs in the test level estimate are taken directly from the element level estimates, which contain the documented estimating methodologies, risk analysis, and other source data. Specifically, when we initially compared the estimates, in most cases, the costs varied by 50 percent or more, with the costs consistently higher in the test level estimate. MDA Cost Directorate officials were able to reconcile some of the variances by creating a crosswalk and verbally explaining the misalignments. Per best practices, a cost estimate should be easily understood and replicated by someone other than those who prepared it; otherwise, questions about its credibility arise.

- **No documented policy or guidance for the process or software application used to create test level estimates provided by MDA.** We found, based on available data, documentation provided by DOD, and interviews with relevant officials, that MDA does not have documented policy or guidance related to its process for creating test level cost estimates. An agency's processes, such as those for cost estimating, should be documented in policy and, in order to be effective, include guidance on the who, what, when, where, how, and why of the process.[41] Without such, it introduces the possibility of mistakes and misinformation. For example, we asked various MDA officials about the test level estimates and received different and sometimes conflicting responses. However, MDA did not provide a documented policy or guidance with specific details with which to weigh the responses against. MDA had an independent contractor assess the software application used to create its test level estimates in 2014, and the findings from this assessment include the need to document the process in its policy and to create guidance for using the software application.[42] Consequently, MDA has been aware of this deficiency for at least three years, although it has yet to take any actions to address it. Without documentation or guidance for this process and software application, MDA has limited and potentially inconsistent means of providing direction to personnel, and management responsible for executing and monitoring it and communicating relevant information to external parties, such as Congress and oversight entities, as needed.

[41]GAO, *Standards for Internal Control in the Federal Government,* GAO-14-704G (Washington, D.C.: Sept. 10, 2014).

[42]Final Report: MDA Integrated Master Test Plan (IMTP) Cost Estimating Model Independent Verification and Validation. MCR Technologies. Feb. 25, 2014.

- **No costs per tests specified in budget submissions or other external documentation**. We found that MDA does not document its test level estimates—total costs per test—in its annual budget submission, and according to MDA officials, this is because there is no requirement to do so. Currently, MDA's annual budget submission includes an overall test funding line for various elements and the Directorate for Testing, but we found that neither the specific tests for which it is requesting funding nor the costs of each are delineated. Similarly, MDA's BAR which presents the current estimate for its baselines includes an overall test funding line for each element. The issue is that MDA regularly makes changes to the integrated test schedule, a companion document to the BAR, without identifying the corresponding effects or impacts to its costs and funding needs, despite our prior recommendation to do so.[43] Without a breakout of MDA's costs by test in its annual budget submission and BAR, how many times or how much funding has been requested, received, or used for a specific test will continue to be unclear.

Accurate. An estimate is accurate if it is unbiased, based on the most likely costs, and has few or no mathematical mistakes.

- **Actual costs are not collected.** We found that MDA continues to have challenges tracking the actual amounts it spends per test.[44] Tracking actual amounts spent is important because they are the foundation for credible cost estimates and can facilitate internal and external oversight and accountability. One of the reasons MDA has been challenged to track actual amounts spent is because it does not use a common WBS for test costs. Another reason is that the elements have coded the actual amounts they have spent differently in the payment application used to expend funding. Consequently, the inconsistent data on the front end (the WBS) and the backend (the payment system) has prevented MDA from aggregating the data for an accurate total amount spent on a test. MDA recognizes its challenge in this regard and in response, it recently issued a memo and accompanying guidance that requires the use of specific naming

[43]GAO-11-372.

[44]GAO-16-339R.

conventions when coding test cost data with the goal of capturing and reporting the complete and accurate cost information for each test.[45]

- **Inconsistent costs provided for tests in response to information request.** We found that when MDA has responded to a number of information requests from a congressional committee or GAO, in certain instances, the information provided has been inconsistent. For example, MDA has reported the total costs for a specific test using its test level cost estimates, but the information for the same test has been inconsistent across requests. Specifically, for one test we received an estimate of $261 million and later received an estimate of $26 million for that same test. Similarly, for another test, Congress received an estimate of $212.1 million and we received an estimate of $51.01 million for the same test. According to MDA Cost Directorate officials, these inconsistencies are attributable to fiscal year boundaries set within the test level estimate that exclude some prior and future costs. Accordingly, MDA has made adjustments to these fiscal year boundaries to capture all prior costs and future costs through fiscal year 2030, per Cost Directorate officials. While we could tie MDA's rationale to some of the inconsistencies, we could not do so for all. Moreover, although we requested clarification, MDA has been unable to provide a detailed, documented reconciliation for these varying estimates.

MDA officials agreed with the identified shortcomings in both its element and test level estimates. However, they did not elaborate on any specific actions they are currently or planning to take for improving element and test level estimates. Until MDA resolves the deficiencies in its element and test level cost estimates, specifically the use of the common test WBS, documenting the traceability of source data, breaking out costs by tests in budget submission and agency documentation, and codifying processes in policy, the lack of transparency for test costs and inconsistently reported data are likely to continue.

[45]MDA, Individual Flight Test Costs Standard Operating Procedures, Sept. 27, 2016, and Memorandum for Capturing and Execution Reporting of Individual Flight Test Costs, Sept. 28, 2016.

MDA Incorporated Several Elements of a Sound Business Case for Its Next Generation Efforts but Concerns with Requirements and Acquisition Strategies Could Hamper Efforts

MDA currently has several efforts underway for exploring, developing, producing, and delivering its next generation of ballistic missile defense capabilities. MDA has taken steps to enhance the business case for its next generation efforts by performing early concept exploration, maturing technologies, and promoting competition for some efforts. MDA also incorporated input from DOD components for some of its next generation efforts, reducing acquisition risks and improving department-wide support for these programs. However, the requirements for MDA's next generation efforts are missing warfighter-validation and approval and generally reflect the needs of MDA ahead of the warfighter. For example, warfighter and DOD components have voiced their concerns with aspects of system design for a new long-range radar, an improved kill vehicle for the GMD interceptors, and a new space-based sensor to help assess the results of intercepts. Moreover, organizations within the Office of the Secretary of Defense have voiced concerns with the acquisition strategy for the improved kill vehicle, particularly with decisions to limit competition. MDA did not address these concerns and has made trade-off decisions that reduce acquisition cost but potentially compromise performance to the extent that the new systems may not be able to perform their intended mission to defeat the current and future threat.

MDA Has Several Efforts Underway for Exploring, Developing, Producing, and Delivering Its Next Generation of Ballistic Missile Defense Capabilities

MDA is developing advanced technologies to adapt to threat changes with the goal of deploying a future BMDS architecture more capable of discriminating and intercepting incoming missiles with a higher degree of confidence, allowing the warfighter to improve its protection against evolving threats. According to MDA, the advanced technologies are determined by systems engineering to identify emerging technical solutions that will best address gaps in the BMDS and enhance the system's overall capability and performance. As MDA looks to the future, not only is it considering what capabilities are needed to defeat the evolving threat, it is also considering what improvements are necessary to improve the current set of deployed systems, fix known problems, and deliver outstanding capabilities that have been delayed over the years.

However, MDA also faces budgetary challenges of balancing and prioritizing its portfolio of new investments while also supporting existing systems—all within a department-wide portfolio of competing priorities. MDA's next generation efforts represent a significant investment as the agency plans to spend over $5.5 billion on these efforts over the next five years. Table 6 below describes MDA's next generation efforts that span the 2020 and beyond time frame.

Table 6: Description of the Missile Defense Agency's (MDA) Next Generation Efforts

	Name	Description
Research, concept exploration, technology demonstration, and experimental efforts:	Advanced Concepts and Performance and Evaluation	MDA is centralizing all advanced technology concept modeling, simulation, software, and analysis and utilizing subject matter experts to provide assessments of government, university, and industry technology concepts, such as kill vehicles, discrimination sensors, space alternatives, and directed energy systems.
	Advanced Research	MDA is conducting research and development to create and enable future missile defense capability. Top focus areas for the agency include testing radiation-hardened optical components, initiating a nano-satellite technology testbed for kill vehicle components, and developing advanced materials in support of BMDS applications.
	Advanced X-Band Radar	MDA is developing target acquisition and discrimination algorithms for transition to program elements for further development and integration into BMDS X-Band Radars. MDA plans to use modeling, simulation, and online/offline assessments of live tracking opportunities to assess development algorithms prior to transition in an effort to reduce risk. Mid-term improvements are planned to field in FY 2019 and far-term improvements around FY2022- FY 2025.

	Name	Description
	Directed Energy	MDA is exploring two concepts with the goal of integrating a compact, efficient, high power laser into a high altitude, long endurance aircraft capable of carrying the laser and destroying targets in the boost phase. In FY 2019, MDA plans to evaluate both concepts and select the best approach to continue development by FY 2022.
	Discrimination Sensor Prototype Development	MDA is funding development of an advanced airborne sensor system, using the operational MQ-9 Reaper unmanned aircraft system. MDA intends to concentrate its efforts on developing advanced detectors, infrared sensors, and precision tracking and discrimination algorithms. According to MDA, the MQ-9 Reaper equipped with an advanced sensor could provide a viable quick reaction capability to augment BMDS radars. MDA plans to flight test the effort in FY 2019-2021 to achieve operational availability as early as 2023 for a short duration surge capability.
	Medium Range Ballistic Missile Defense Sensor	MDA is planning to initiate concept development and analysis for emplacing a new, medium range ballistic missile defense sensor intended to improve the defensive coverage of Hawaii. MDA previously indicated that preliminary analysis from a global BMDS sensor system analysis of alternatives showed the best approach to improve the defense of Hawaii is to implement an upgraded version of the Army Navy/Shipboard Radar Surveillance and Control Model 1 radar. However, according to multiple DOD components, the analysis of alternatives did not identify the upgraded radar as the best approach and that the department will determine a capability to pursue once the study is complete. Preliminary estimates indicate MDA could field the sensor sometime between FY 2018 and FY 2030, depending on the sensor solution that is selected.
	MOKV	MDA is developing an advanced capability to destroy several objects within a threat complex using multiple kill vehicles carried on a single interceptor. MDA is currently focusing on competitive development and risk reduction of MOKV concepts with industry in an effort to lower developmental risk. MDA plans to deploy interceptors equipped with MOKVs around the FY 2029 time frame.
	SKA	MDA is developing and producing a network of small infrared sensors integrated onto commercial host satellites as an experiment to demonstrate kill assessment from space. While on orbit, these sensors are intended to observe missile defense intercepts and deliver a kill assessment declaration. MDA plans for the network to begin on-orbit deployment in FY 2018, according to a current estimate from the commercial host. A warfighter evaluation of the systems is expected to follow shortly thereafter to determine whether to transition the system into an operational role.
	THAAD follow-on	MDA is undertaking a risk reduction effort to explore and mature a design concept, validate the threat assessment, and develop a life cycle cost estimate for a potential THAAD follow-on program. MDA is seeking to increase THAAD's capabilities, such as extending interceptor range and improving sensor performance, to expand battlespace and defended area, increase THAAD's interoperability with other air and missile defense systems, and incorporate threat upgrades to keep pace with adversary advances, including hypersonic glide vehicles. MDA plans to evaluate the technical merits and affordability of these future capability improvements with potential deployment around FY 2025.
Programs undergoing development:	Improved Homeland Defense Interceptors	MDA is redesigning the Ground-based Midcourse Defense kill vehicle, known as the Redesigned Kill Vehicle (RKV) to address ongoing reliability concerns with the current GMD kill vehicle. According to MDA, the RKV will be designed to be more reliable, producible, testable, and cost-effective. MDA also plans to improve the ground system and modify the boost vehicle with tactical upgrades to enhance survivability and expand capabilities against emerging threats. MDA plans to begin fielding interceptors equipped with RKVs starting in FY 2022.

Name	Description
LRDR	MDA is developing LRDR to address the need to provide persistent, precision tracking and discrimination capability in the Pacific sensor architecture. MDA anticipates the addition of LRDR will optimize employment of the GMD interceptor inventory and address evolving threats. The radar will be located at Clear Air Force Station, Alaska, with initial operational capability planned for 2020.

Legend:
BMDS = Ballistic Missile Defense System
FY = fiscal year
LRDR = Long Range Discrimination Radar
MOKV = Multi-Object Kill Vehicle
RKV = Redesigned Kill Vehicle
SKA = Space-based Kill Assessment

Source: GAO analysis of MDA's FY 2017 budget request. |GAO-17-381

Business Case for MDA's Next Generation Efforts Enhanced by Maturing Technologies, Performing Early Concept Exploration, Promoting Competition, and Working with DOD Components

MDA is pursuing a number of concept exploration, advanced research, technology demonstration, and experimental efforts with a goal to transition promising, cutting-edge technology into BMDS applications. These efforts are aimed at proving technologies work as intended before transitioning to a weapon system program, which our prior work on acquisition best practices has shown to be beneficial in minimizing development risks in new programs.[46] In addition, MDA is incorporating aspects of DOD's Better Buying Power initiative by making use of prototypes, emphasizing technology insertion, involving industry in funded concept definition efforts, promoting competition in some efforts, attempting to achieve affordable programs and dominant capabilities, and incentivizing productivity in industry and government.[47]

MDA is maturing technologies and making use of prototypes as part of its Directed Energy and Discrimination Sensor efforts. MDA's previous attempts at quickly developing and fielding a capable, operationally suitable, directed energy system and airborne infrared sensor system proved unsuccessful.[48] However, according to MDA, advancements in the field of laser technology may now make it possible for the agency to successfully transition the technology into an operationally effective missile defense application. Further exploration of unmanned aircraft vehicles and sensors that typically perform an information, surveillance, and reconnaissance mission for the U.S. Air Force may also allow MDA

[46]GAO/NSIAD-99-162.

[47]DOD's Better Buying Power initiative outlines a series of actions, guidance, and directives aimed at increasing the productivity, efficiency, and effectiveness of DOD's acquisition, technology, and logistics efforts. See e.g., Office of the Under Secretary of Defense, Acquisition, Technology and Logistics Memorandum: "Implementation Directive for Better Buying Power 3.0—Achieving Dominant Capabilities through Technical Excellence and Innovation" (Apr. 9, 2015).

[48]The Airborne Laser program was designed as a high-energy chemical laser onboard an airplane designed to intercept missiles. The Airborne Infrared program was designed to track ballistic missiles shortly after launch by utilizing infrared sensors onboard select unmanned aircraft systems. Both programs were canceled by DOD in 2012. We previously found these programs faced significant challenges in developing and demonstrating an operationally useful capability. See GAO-11-372.

to make use of these existing capabilities in a missile defense application. By maturing technologies and making use of prototypes in each of these fields, MDA is reducing the potential for costly, time-consuming development challenges arising during the technology development phase, if and when MDA decides to transition these efforts back to weapon system programs. These efforts are consistent with the recommendation we made in 2006 that DOD programs should demonstrate they have captured appropriate knowledge at program start, which includes, ensuring that requirements are informed by the systems engineering process.[49]

MDA is also executing advanced research efforts to promote the insertion of promising technologies into new or existing programs by funding universities and small businesses to research and develop technologies which the agency hopes will spur major advancements in missile defense capability, decrease the time to transition applications into the BMDS, and promote a healthy industrial base by commercializing technology developed for the BMDS into private sector applications. An agency-wide executive level Research Council is tasked with identifying priorities and balancing the research portfolio. In fiscal year 2016, the MDA Research Council approved over 150 contract actions to test the scientific, technical, and commercial feasibility of particular concepts. These efforts are consistent with the recommendation we made in 2006, that in order to ensure that a sound business case is developed prior to starting system development, DOD should set aside a portion of advanced component development and prototype funds for the science and technology community to manage the transition of technologies to acquisition programs.[50]

In addition, MDA is performing concept exploration activities in an effort to prove concepts work before transitioning them to a weapon system. Prior to initiating the Redesigned Kill Vehicle (RKV) program, for example, MDA performed a concept definition program where the agency contracted with three contractors to propose kill vehicle design solutions and perform technology maturity assessments. MDA plans to perform a similar effort for the Multi-Object Kill Vehicle (MOKV) program. Moreover,

[49]GAO, *Defense Acquisitions: Major Weapon Systems Continue to Experience Cost and Schedule Problems under DOD's Revised Policy*, GAO-06-368 (Washington, D.C.: Apr. 13, 2006).

[50]GAO, *Best Practices: Stronger Practices Needed to Improve DOD Technology Transition Processes*, GAO-06-883 (Washington, D.C.: Sept. 14, 2006).

MDA has two directed energy concept exploration efforts underway to determine whether the technology is currently far enough along to where it can be developed into a missile defense application. These efforts are consistent with the recommendation we made in 2008 that DOD should have contractors perform more detailed systems engineering analysis to develop sound requirements before DOD selects a prime contractor for the system's development contract.[51]

MDA is also promoting competition in its next generation efforts, potentially increasing the value for resources spent on acquiring new weapon systems. For example, MDA conducted a competitive source selection for the Long Range Discrimination Radar (LRDR), which, combined with an emphasis on cost realism, savings, and controls, places the program in a positive position for delivering capabilities within budget. MDA is also incorporating some elements of competition for RKV by employing a modular open systems architecture and plans to compete a full-rate production contract.[52] Our prior work on defense contracting shows that incorporating an open systems architecture—a system that uses modular design and consensus-based standards for its key interfaces—and the acquisition of appropriate data rights (e.g., design drawings, specifications, and standards) during program development can result in greater competition and reduce costs during production.[53] Further, incorporation of an open systems architecture and management of data rights can lead to greater competition and reduced upgrade and repair costs over a program's life cycle.

In addition to maturing technologies and promoting competition, MDA is also incorporating input from DOD components. Specifically, MDA is working with the Deputy Assistant Secretary of Defense for Developmental Test and Evaluation DASD(DT&E) to develop a

[51]GAO, *Best Practices: Increased Focus on Requirements and Oversight Needed to Improve DOD's Acquisition Environment and Weapon System Quality*, GAO-08-294 (Washington, D.C.: Feb. 1, 2008).

[52]A modular open systems architecture is a design approach similar to that of a personal computer where system components can be added, removed, modified, replaced, or sustained by consumers or different manufacturers in addition to the manufacturer that developed the system. MDA's full production, similar to DOD's full-rate production, is used primarily to produce final operational end items to satisfy Warfighter-capability requirements.

[53]GAO, *Defense Contracting: Early Attention in the Acquisition Process Needed to Enhance Competition*, GAO-14-395 (Washington, D.C.: May 5, 2014).

Developmental Evaluation Framework for LRDR and RKV. According to DASD(DT&E)'s fiscal year 2015 annual report, the framework serves as a test and evaluation road map and is used to support sound acquisition program decisions by showing the correlation between test events, key resources, and the decision supported.[54] In its fiscal year 2014 report, DASD(DT&E) recommended that all new work or redesign activities by MDA should use a Development Evaluation Framework. According to DASD(DT&E) officials, MDA has worked with them to develop an initial, first-order framework for both LRDR and RKV. MDA is currently performing the technical breakdowns to ensure sufficient detail is included to support its test and evaluation efforts. By coordinating with DASD(DT&E) to develop the framework for both LRDR and RKV, MDA is leveraging the knowledge and experience of individuals outside of the agency, potentially increasing department-wide buy-in for the programs.

MDA is also exploring alternative approaches to fielding needed space-based capabilities to address affordability and threat-based challenges typically associated with defense space acquisitions. In 2013, we found that, given the significant expense of space programs and the federal government's fiscal limitations, agencies may be able to leverage opportunities for hosted payloads on commercial satellites to achieve significant cost savings.[55] To this end, MDA is pursuing an experimental system, called Space-based Kill Assessment (SKA), to potentially provide needed capability to the warfighter about whether an incoming, lethal enemy ballistic missile was successfully intercepted. MDA plans to deploy a network of sensor payloads hosted onboard commercial satellites scheduled to be launched by the end of 2018. In addition to ensuring the program is more affordable, agency officials stated that MDA is also using the program as a pathfinder to identify cost-saving measures for future space-based capabilities the agency may pursue to make fielding assets

[54]Deputy Assistant Secretary of Defense, Developmental Test and Evaluation, *Department of Defense Developmental Test and Evaluation: FY 2015 Annual Report* (March 2016).

[55]GAO, *2013 Annual Report: Actions Needed to Reduce Fragmentation, Overlap, and Duplication and Achieve Other Financial Benefits*, GAO-13-279SP (Washington, D.C.: Apr. 9, 2013).

in space more affordable—a challenge the department has struggled with for over the past 30 years.[56]

MDA plans to obtain an independent cost estimate from DOD's Office of Cost Assessment and Program Evaluation (CAPE) for both the LRDR and RKV programs.[57] According to GAO best practices guide for estimating and managing program costs, conducting an independent review of a cost estimate is crucial to establishing confidence in the estimate, because, as part of the review process, the estimate is verified, modified, and corrected to ensure realism, completeness, and consistency.[58] However, due to the acquisition flexibilities it has been granted, the requirement to obtain independent cost estimates before beginning system development and/or production and deployment does not yet apply to MDA. Instead, CAPE prepares estimates only at MDA's request. Since we began annual reporting on missile defense in 2004, we have been unable to assess overall progress on cost because the cost information MDA reported over the years has lacked sufficient quality. Because Congress was limited in its ability to evaluate the near- and long-term budget implications of decisions to develop and field BMDS elements, in 2008, we recommended the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) establish a requirement to estimate BMDS costs using independently validated estimates.[59] In 2014, we found that although MDA had taken positive steps to improve the quality of its cost estimates, including

[56]Since 1984, DOD has spent several billions of dollars on space-based missile tracking programs—such as Space-Based Infrared System-low, Space Tracking and Surveillance System, and most recently, Precision Tracking Space System—but has yet to operationally field such a capability. The Precision Tracking Space System was canceled in 2013, in part, because of affordability concerns, as the program was projected to cost as much as $22.5 billion over the life of the program. For more information, see GAO, *Missile Defense: Precision Tracking Space System Evaluation of Alternatives*, GAO-13-747R (Washington, D.C.: July 25, 2013) and *Missile Defense: Alternate Approaches to Space Tracking and Surveillance System Need to Be Considered*, GAO-03-597 (Washington, D.C.: May 23, 2003).

[57]CAPE is the office responsible for, among other items, directly providing the Secretary of Defense with independent, analytic advice on the cost-effectiveness of defense systems and fitting the defense program to the budgetary limits set for the department by the president and Congress.

[58]GAO-09-3SP.

[59]GAO, *Missile Defense: Actions Needed to Improve Planning and Cost Estimates for Long-Term Support of Ballistic Missile Defense*, GAO-08-1068 (Washington, D.C.: Sept. 25, 2008).

receiving independent cost estimates from CAPE, about half of the cost baselines for MDA programs remained unverified.[60] As such, obtaining independent cost estimates from CAPE would be consistent with our 2008 recommendation on cost estimates and a recommendation we made in 2010 that MDA obtain CAPE independent cost estimates.[61] Consequently, obtaining independent cost estimates could increase buy-in from within the department for the LRDR and RKV programs because it would increase confidence that MDA has a reasonable understanding of the systems' expected costs. This may provide decision makers confidence that the funding MDA requests is based in realism and better reflect the actual resources the agency needs.

MDA's Requirements for Its Next Generation Efforts Include Warfighter's Input, but Not Validation and Approval

MDA's Requirement-Setting Process

Most DOD weapon system programs are managed within DOD's acquisition framework, which includes distinct, decision-support processes for determining requirements and managing the acquisition system. Each process is managed and overseen by different organizations—also referred to as components—and leaders within DOD and the military departments. At the DOD level, the USD(AT&L) is responsible for the acquisition function and the Joint Chiefs of Staff are responsible for implementing the requirements process through what is called the Joint Capabilities Integration and Development System (JCIDS). As part of this process, high-level, operational requirements of major weapon systems are first generated, vetted, and put forward for DOD-level review and approval. Following military service-level reviews and approvals, the high-level operational requirements are assessed and validated by the Chairman of the Joint Chiefs of Staff with the advice of the Joint Requirements Oversight Council (JROC), which is comprised of the Vice Chiefs of Staff of each military service. High-level requirements go through a refinement process in the early stages of an acquisition

[60]GAO, *Missile Defense: Cost Estimating Practices Have Improved, and Continued Evaluation Will Determine Effectiveness*, GAO-15-210R (Washington, D.C.: Dec. 12, 2014).

[61]GAO, *Defense Acquisitions: Missile Defense Transition Provides Opportunity to Strengthen Acquisition Approach*, GAO-10-311 (Washington, D.C.: Feb. 25, 2010).

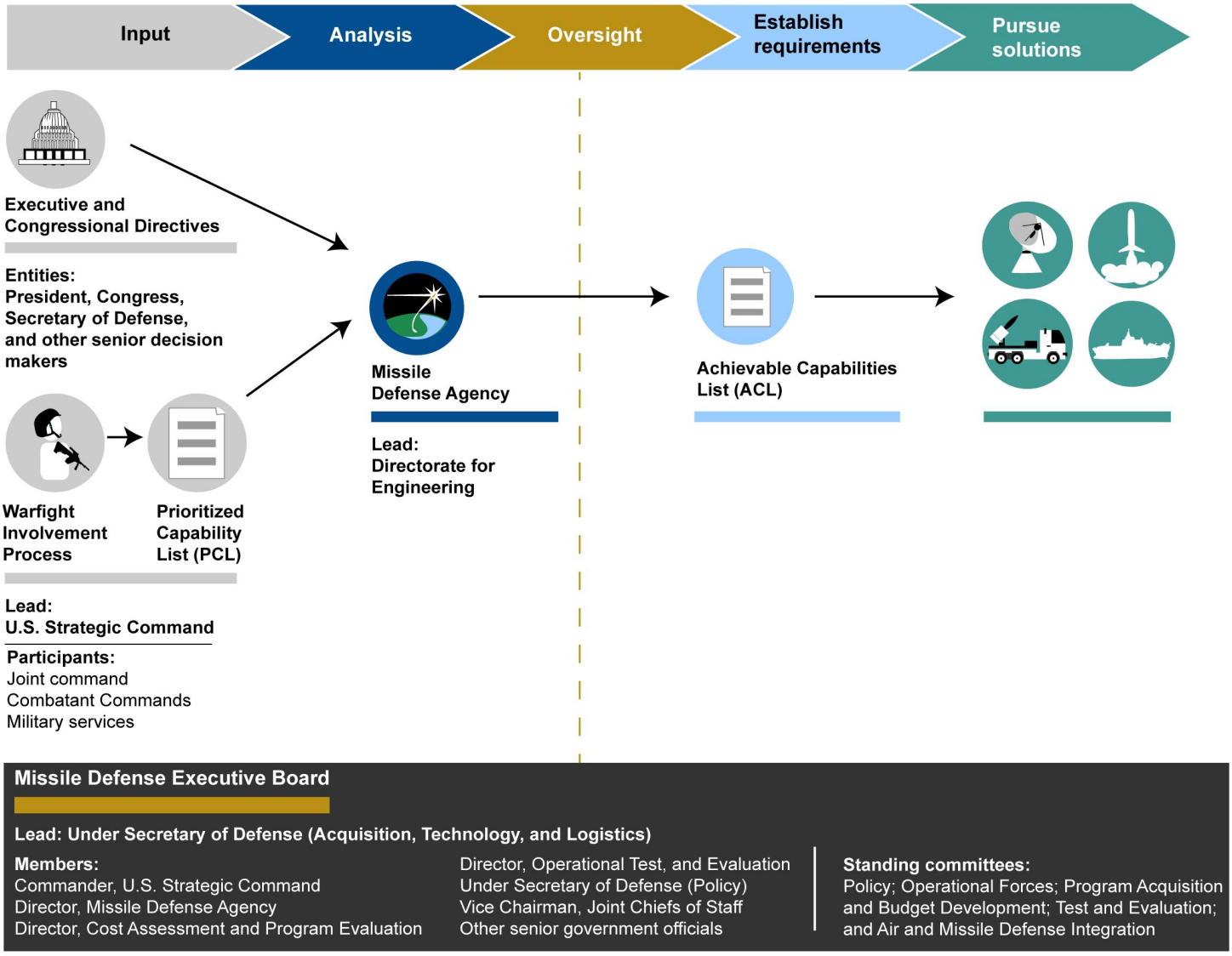
program, where the requirements are broken down into technical requirements and then specifications. As the acquisition program goes through the iterative phases of the acquisition process, the military service chief's role diminishes and the acquisition executive's role becomes more prominent.[62]

MDA's unique acquisition authorities include exemption from the JCIDS process, including oversight and validation of missile defense requirements from the JROC. Instead, as described in Figure 10 below, MDA follows a unique requirements-setting process that starts with a Warfighter Involvement Process where U.S. Strategic Command, representing the views of all the combatant commands, military services, and joint staff, articulates missile defense capabilities needed in a Prioritized Capabilities List (PCL). MDA assesses the PCL based on whether the capabilities are affordable and achievable in a given time and with realistic technology. In addition, MDA also performs its own analysis to identify capability needs and gaps. This effort results in a document produced by MDA called the Achievable Capabilities List (ACL). The ACL is intended to document the MDA program of record compared against the PCL and addresses the technology, budget, schedule, or other factors regarding the implementation of each desired warfighter capability. Once MDA approves the ACL, it is briefed to the agency's oversight board, the Missile Defense Executive Board (MDEB), and becomes the requirements by which the agency operates. The warfighter evaluates the ACL for adequacy and sufficiency to inform the standing committees within the MDEB, which includes an operational forces standing committee that is chaired by the Deputy Commander of U.S. Strategic Command. Although the ACL is subject to MDEB oversight, the document is not coordinated with, nor is it subject to, warfighter review or approval before the document is finalized. According to officials from MDA and USD(AT&L), differing views between MDA and the warfighter regarding the requirements MDA should pursue are typically resolved in DOD's budget planning process, where compromises are reached to fund important warfighter priorities that may not be addressed by the ACL.

[62]According to the U.S. Senate Armed Services Committee, the National Defense Authorization Act for Fiscal Year 2017 includes a series of provisions intended to clarify the roles of senior acquisition officials in the acquisition process. Changes to DOD's management structure are intended to align responsibilities with the services to the maximum extent practicable while providing a greater role for the Office of the Secretary of Defense to lead on innovation and provide effective and targeted oversight on major weapon systems programs.

Figure 10 provides a graphic detailing MDA's requirement setting process.

Figure 10: Notional View of Missile Defense Agency's (MDA) Requirement-Setting Process



Source: GAO analysis of MDA policy and guidance. | GAO-17-381

MDA's requirements-setting process is designed to expeditiously define requirements and allow flexibility for MDA to respond to evolving needs and changes to the threat. Under this process, the "developer" (i.e., MDA) instead of the "user" (i.e., the warfighter) sets the requirements. Allowing

MDA to define both the high- and low-level requirements enables the agency to make trades between resources and performance attributes, which provides the agency with significant flexibility to make fundamental changes to what it ultimately delivers to the warfighter. MDA refers to this approach as “capability-based acquisitions” where requirements are established based on an uncertain and evolving threat rather than a validated threat assessment. As part of this approach, a desired capability is identified but, rather than developing firm, informed requirements up front, the end-state requirements are unknown at program initiation. The requirements are expected to be refined through demonstration, managing risk, and continuous warfighter feedback.

Although MDA establishes its own requirements, it receives input from the warfighter. For example, MDA’s Joint Warfighter Support Program is tasked with engaging the warfighter through the Warfighter Involvement Process to identify gaps, seams, and needs in warfighting capability. In addition, according to officials, the MDEB’s governance structure is chartered to harmonize any issues associated with the BMD program efforts and includes standing committees, such as the Operational Forces Standing Committee. If disagreements exist between MDA and the warfighter, the MDEB’s standing committees are designed to resolve the issues before the MDEB convenes. In addition, as part of the ACL development effort, MDA’s process includes assessing and correlating the warfighter-provided PCL with the MDA program of record, mapping out each of the warfighter’s priorities with capabilities that MDA either currently plans to deliver or capabilities the agency plans to consider. Moreover, the ACL also incorporates capability gap assessments performed by the Joint Staff into the ACL in an effort to engage the warfighter and ensure their concerns are considered in the requirements the agency pursues.

Requirements Missing Warfighter Validation and Approval

By allowing MDA to define the full range of requirements and not requiring the agency to go through a process to validate its requirements, there is the potential that the agency may pursue solutions that are unnecessary, insufficient, or not a priority. Under JCIDS, requirements undergo a rigorous, multi-step process to verify the existence of a capability gap and that a solution is needed. However, requirements established in the ACL do not undergo a similar validation and approval process. For example, in 2008, the military services, Joint Staff, and Combatant Commands voiced concerns that they have insufficient involvement in the requirements process and that the JROC role in

MDA's requirement-setting process is inadequate.[63] Although changes have been implemented to improve warfighter involvement, limitations continue to exist. For example, MDA does not follow the JCIDS process and is not required to submit the requirements established in the ACL for its next generation efforts to the JROC. However, in 2014, MDA performed some limited outreach with the JROC and obtained the board's acceptance for a set of broadly-outlined goals and attributes of homeland ballistic missile defense. This was the first requirements document to go through the JROC since the start of the BMDS program in 2002, according to the Joint Functional Component Command for Integrated Missile Defense (JFCC IMD). Led by U.S. Strategic Command, JFCC IMD is comprised of warfighter personnel from the military services and is tasked with synchronizing missile defense plans, conducting missile defense operations support, and advocating for missile defense capabilities.

MDA's outreach to the JROC afforded the council with the opportunity to shape the baseline for current and future homeland missile defense capabilities, according to the Vice Chairman of the Joint Chiefs of Staff. However, the JROC's input was limited to reviewing broadly-defined goals and the council did not validate or endorse specifically-defined BMDS requirements. For example, according to MDA's fiscal year 2016 budget request documentation, the JROC was briefed and concurred with the LRDR requirements in the fall of 2014. In addition, the Director, MDA stated in an April 2016 hearing before the House Armed Services Subcommittee on Strategic Forces that the agency was able to navigate the LRDR requirements through the JROC in about 6 weeks.[64] However, neither the JROC memorandum nor the briefing cited by MDA that was presented to the JROC included any specific mention of LRDR or the program's requirements. Rather, the JROC accepted broadly-defined operational attributes, such as assuring homeland BMDS assets are interoperable and sufficiently robust to perform in a spectrum of conditions. Although the JROC's review and acceptance of these broadly-defined attributes is noteworthy, it does not reflect the committee's validation or concurrence with system-specific requirements.

[63]Institute for Defense Analysis: *Study on the Mission, Roles, and Structure of the Missile Defense Agency (MDA)*, IDA Paper P-4374 (Alexandria, Va.: Aug. 2008).

[64]*The Missile Defeat Posture and Strategy of the United States—The FY17 President's Budget Request*, *Before the H. Armed Services S. Comm. on Strategic Forces*, 114th Cong. (2016) (statement of Director, Missile Defense Agency Vice Admiral James Syring).

While MDA's current requirements-setting process does not require coordination or approval of the ACL from the warfighter, according to U.S. Northern Command—the warfighter primarily responsible for defending the United States homeland from ballistic missile attacks—coordinating the ACL with the warfighter would be a straight-forward tasking. However, according to officials from MDA and Office of the USD(AT&L), the warfighter is provided with an opportunity to express its views of the ACL in the operational forces standing committee, and, if necessary, bring its concerns to the MDEB. Although the MDEB has the authority to make changes to the ACL, since the oversight board's formation in 2009, it has never required MDA to make a change to the ACL. Moreover, there is no mechanism within the ACL-development process to allow MDA and the warfighter, at the working level, to address disagreements nor is there a process for the warfighter to appeal or amend the ACL once it is approved by MDA.

DOD has recently initiated reviews of MDA's requirement-setting process, the MDEB's oversight process, and aspects of the ACL that impact the warfighter, which may influence MDA's requirements-setting process. In 2016, the MDEB established plans to assess MDA's oversight and acquisition processes. As part of this effort, the USD(AT&L) plans to assess how it can optimize the MDEB and its standing committee's process and requested the Joint Staff and U.S. Strategic Command to review MDA's requirement-development and validation process. In addition, JFCC IMD stated that in 2017, it plans to produce a Global Integrated Air and Missile Defense Assessment that will include an assessment of the ACL to review aspects that impact the warfighter. These reviews have the potential as being initial steps for determining whether departmental changes to MDA's requirement-setting process are needed and, if so, what those changes should include.

Decisions Made on Three New Efforts Reflect Requirements-Setting Challenge

The technical requirements for some of MDA's next generation efforts, such as LRDR, RKV, and SKA, reflect an emphasis on the developer's concerns ahead of the warfighter's concerns and do not address some issues raised by DOD components. Under the JCIDS process, requirements should generally reflect the needs of the warfighter and—as we found in 2011—sometimes do not include trade-offs important to the

developer, namely cost and schedule objectives.[65] Conversely, under MDA's requirement-setting process, the requirements for MDA's next generation efforts generally reflect the needs of the developer ahead of those of the warfighter. For example, design approaches for LRDR, RKV, and SKA include trade-offs that favor fielding capabilities sooner and less expensively. However, officials from multiple DOD components have warned these trade-offs compromise performance and reliability, potentially resulting in the warfighter receiving capabilities that are insufficient to defeat the current and future threat. DOD has previously cancelled missile defense programs when technical challenges and affordability concerns were too great for the department to justify continuing the efforts.[66] In addition, research published by DOD's Defense Acquisition University indicated that several factors greatly influence defense acquisition program termination, including, having an inadequate requirements definition process, lack of understanding of the operational environment, failure to get stakeholder buy-in, and a lack of communication with stakeholders.[67] If MDA does not address concerns from DOD components, and performance risks for LRDR, RKV, and SKA manifest, the programs may experience significant disruptions to address the problems and the department may face a similar decision about whether to continue pursuing these systems. For example:

- *LRDR:* MDA's planned use of the S-band frequency for LRDR meets MDA's needs to quickly and affordably acquire the system but may lack sufficient performance margin to meet the warfighter's needs. Our prior work on improving defense acquisitions has shown that early involvement from stakeholders, such as engineers and testers, in pre-system development reviews helped facilitate requirement trade-offs and reduced the risk for cost and schedule growth.[68] Analysis of potential LRDR frequencies performed at the request of

[65]GAO, *DOD Weapon Systems: Missed Trade-off Opportunities During Requirements Reviews*, GAO-11-502 (Washington, D.C.: June 16, 2011).

[66]GAO-14-351 and GAO-13-432.

[67]Lt Col Patrick Clowney, USAF (Ret.), Jason Dever, and Steven Stuban, "Department of Defense Acquisition Program Terminations: Analysis of 11 Program Management Factors," *Defense Acquisition Research Journal*, vol. 23, no. 3, (2016).

[68]For examples, see GAO, *Defense Acquisitions: Better Approach Needed to Account for Number, Cost, and Performance of Non-Major Programs*, GAO-15-188 (Washington, D.C.: Mar. 2, 2015); and *Weapons Acquisition Reform: Reform Act Is Helping DOD Acquisition Programs Reduce Risk, but Implementation Challenges Remain*, GAO-13-103 (Washington, D.C.: Dec. 14, 2012).

MDA by a panel of federally funded research and development centers and university affiliated research centers in December 2014 indicated that both the X-band and S-band frequencies could meet the requirements established by MDA for the radar. In addition, MDA's market research indicated that the use of S-band opened up some more affordable options from industry that may not have been available had it selected X-band. According to MDA officials, they briefed senior-level officials from the MDEB's operational forces standing committee about its plans to select the S-band and received approval from the MDEB to proceed. However, MDA did not consult JFCC IMD—the military personnel who advocate for needed capabilities and provide operational support for BMDS radars—regarding the planned use of S-band for LRDR and any potential limitations that might exist. Moreover, results from the December 2014 LRDR frequency study also indicated that less design margin exists with S-band, as the data would need to be improved to that of X-band performance level to meet requirements. DASD(DT&E) officials expressed concerns that inherent limitations exist within LRDR's design selection, beyond radar band selection, that are significant enough to raise doubts as to whether LRDR can perform meaningful discrimination.

In addition, MDA plans to declare LRDR ready for use in fiscal year 2020 based on a schedule that saves time through concurrent system development and production, which benefits MDA but transfers risk to the warfighter and local communities. MDA has previously deployed assets prior to warfighter acceptance based on deadline-driven schedules that transferred operational risk and implementation challenges to the warfighter. For example, in 2006, we found that MDA succeeded in fielding the first block of initial missile defense capability, but the block included fewer components than planned, cost more than anticipated, and its performance was unverified.[69] More recently, in 2014, we found that MDA deployed assets in Europe although arrangements for working with allies and construction on infrastructure, such as housing and dining facilities for soldiers, had yet to be completed.[70] Similarly, MDA plans to declare LRDR as operationally available to the warfighter prior to conducting any flight

[69]GAO, *Defense Acquisitions: Missile Defense Agency Fields Initial Capability but Falls Short of Original Goals*, GAO-06-327 (Washington, D.C.: Mar. 15, 2006).

[70]GAO, *Ballistic Missile Defense: Actions Needed to Address Implementation Issues and Estimate Long-Term Costs for European Capabilities*, GAO-14-314 (Washington, D.C.: Apr. 11, 2014).

testing that demonstrates the radar's required performance, running the risk that there may be unknown and unmitigated capability gaps in the fielded system, according to MDA. In addition, a November 2016 study of LRDR's power system performed for MDA by a contractor indicated that agreements with the commercial power provider places limitations on the warfighter's ability to operate the radar without consulting the commercial power provider in advance and that emergency activation of the radar could result in other customers having their power supply temporary switched off. Moreover, the study indicated that an assessment of the impact of LRDR's electrical load on the commercial power provider's system was needed and that it had yet to be conducted—an assessment MDA previously told us the agency had performed and found the risk to be low for service interruptions to nearby communities. DASD(DT&E) officials raised concerns that activating LRDR prior to assessing its operational suitability and impact on the commercial power system creates the risk where a failure could potentially present a public safety hazard, causing loss of necessary power integrity to civil resources such as local police and hospitals.

- *RKV:* MDA plans to use the Aegis BMD SM-3 Block IIA seeker—a kill vehicle guidance system component—in the RKV to achieve schedule goals, but the component may not have sufficient performance to defeat some intercontinental ballistic missile (ICBM)-range threats.[71] MDA maintains that the seeker's expected maturity and other key desirable attributes led the agency to choose the seeker. However, the seeker was not designed to perform against an ICBM-range threat and internal MDA and independent analyses indicated the Aegis BMD SM-3 Block IIA seeker may not be the best option available for the RKV. In addition, officials from multiple DOD components, such as DASD(DT&E), U.S. Northern Command, and U.S. Strategic Command, have raised concerns with the seeker's capability to detect and track threats in an ICBM-range environment, which, when combined with the seeker's expected acquisition range, may impact its discrimination capability and warfighter decision timelines.

  As MDA was formulating the RKV acquisition strategy, CAPE officials stressed the need for MDA to carry risk mitigation design efforts for the seeker and other high-risk components. To this end, CAPE and USD(AT&L) officials stated that senior defense officials committed to

[71] Intercontinental ballistic missiles have a range of over 5,500 kilometers.

provide MDA with the necessary funds but MDA declined the offer because, according to the agency, carrying the additional design efforts would require more time to complete development and likely delay delivery of initial production RKVs. U.S. Northern Command officials are currently advocating for MDA to carry a second, alternative seeker design through the program's product development. MDA and JFCC IMD officials acknowledged the concerns and stated that the program will consider developing a second seeker if warranted by the results of analysis presented at the preliminary design review.

- *SKA:* The design approach MDA selected for SKA may be suitable as an experimental effort to observe flight tests; however, according to DOD officials, the agency will likely need to pursue other, more capable solutions to provide the warfighter with the capability to determine whether an enemy-launched, nuclear-armed ballistic missile was successfully intercepted—a capability referred to as kill assessment. For a kill assessment capability to provide useful information that the warfighter can act upon, it must determine, with a high level of accuracy, whether the interceptor: (1) successfully killed the enemy's re-entry vehicle—the payload of a ballistic missile which carries the warhead; (2) hit, but did not kill the re-entry vehicle; (3) missed the targeted object; or (4) intercepted a decoy or other non-lethal object rather than the re-entry vehicle. U.S. Combatant Commanders have repeatedly stressed the need for a kill assessment capability and, over the years, DOD has funded multiple efforts to provide that capability to the warfighter. Although these efforts have provided useful information, the kill assessment mission has proven to be very challenging for MDA and over time, became a low priority for the agency. However, the National Defense Authorization Act for Fiscal Year 2014 required MDA to develop a plan to deliver an improved kill assessment capability by 2019 to support homeland missile defense.[72] In response, MDA proposed the SKA effort, which is intended to be an experiment but will become an operational asset for homeland defense if proven to work as designed.

  The requirements MDA established for SKA enabled the agency to pursue its preferred design approach but are unlikely to meet the warfighter's need for an effective kill assessment capability. MDA determined, without input from the warfighter, that SKA would not be

[72]Pub. L. No. 113-66, § 237 (2013).

required to discern whether the object that was intercepted was, in fact, the re-entry vehicle and not a decoy or other non-lethal—a capability referred to as discrimination. Instead, according to MDA, SKA's design is based on the assumption that the BMDS radars, C2BMC, and GMD interceptors will successfully discriminate the re-entry vehicle—an assumption contraindicated by shortcomings revealed from prior MDA flight testing and capability assessments of the BMDS. JFCC IMD stated that post-intercept discrimination is necessary for an effective kill assessment capability. Without verification that the intercepted object was lethal, the warfighter runs the risk of wasting interceptors on non-lethal objects, or allowing lethal re-entry vehicles to leak through our defenses and strike the United States because the object was falsely identified as non-lethal.

Concerns have also been raised that SKA may be unable to accurately determine, with a high level of accuracy, whether the intercepted re-entry vehicle was killed, and not just hit. MDA designed SKA based on results observed from prior flight testing, which (DASD)DT&E officials stated generally do not represent the engagement scenarios and subsequent impact scene expected to occur when defending the United States from an enemy-launched intercontinental ballistic missiles, which travel at much higher speeds and produce unique impact phenomena. Officials also raised concerns that SKA will rely upon computer models that have not been independently verified and validated, which may ultimately lead to providing the warfighter with unreliable assessments. Findings and observations from prior flight tests, experiments, studies, and analyses performed by researchers and analysts from DOD, NASA, federally funded research and development centers, and other organizations are consistent with DASD(DT&E)'s concerns about the potential limitations of SKA's measurements. To this end, JFCC IMD officials stated that although they are optimistic about the possible capabilities for which SKA intends to provide to the warfighter, it does not view SKA—and its intended design—as a proven, operationally sustainable solution.

MDA's Decision Not to Address Major Concerns with RKV's Acquisition Strategy Could Hamper Support for the Program if Unaddressed

The RKV program lacks department-wide support because organizations within DOD did not fully agree with the program's acquisition strategy and

many of their concerns have gone unaddressed by MDA. Typically, acquisition strategies for new MDA programs are not approved by the USD(AT&L). However, the National Defense Authorization Act for Fiscal Year 2015 required the RKV acquisition plan to be subject to approval by the USD(AT&L), who, in turn, required MDA to coordinate with DOD acquisition components to develop the report.[73] MDA subsequently revised its initial RKV acquisition strategy based on feedback from DOD's acquisition components by reducing some high-risk practices, aligning production decisions with flight testing, and adding schedule margin and an additional flight test. These inputs improved the RKV acquisition strategy and the program's overall business case because it reduced the program's reliance on high risk acquisition practices and resolved concerns that would have potentially gone unaddressed. MDA has previously pursued weapon systems without obtaining sufficient buy-in from within the department. For example, as we found in 2013, a CAPE review of the Precision Tracking Space System determined the program had significant technical, programmatic, and affordability risks—issues we had previously reported and MDA did not address—which led to the Secretary of Defense cancelling the program.[74]

Some DOD components did not fully agree with the RKV acquisition strategy and have raised concerns about the program's design, development method, schedule, and cost. By not addressing these concerns, failing to get department-wide support for the acquisition strategy, and deciding not to implement risk reduction measures for high-risk components, MDA has put the RKV program in jeopardy of following along the same path as the Precision Tracking Space System. For example, in September 2015, CAPE issued a memorandum stating that it remained concerned that the RKV schedule is risky and expects MDA will have to adjust its plans to reflect development delays. CAPE also stated that it was not convinced that the proposed competitive strategy will actually engender competition and that claims of presumed savings are unsubstantiated. DOD acquisition officials expressed concerns that MDA's modular design architecture will provide little-to-no benefit for improving competition. DOD officials continue to state MDA will be reliant upon the specific contractors who designed the RKV's subsystems to continue to participate in full-rate production in order to avoid any delays

[73]Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015, Pub. L. No. 113-291, § 1663(d) (2014).

[74]GAO-13-747R.

that might result from competitively selecting different suppliers. If the design also changed, the delays would be even further exacerbated. As such, CAPE recommended the program report regularly to an oversight subcommittee within the MDEB on its progress and challenges.

Officials from multiple components within the Office of the USD(AT&L) have raised other similar concerns which MDA declined to address. For example, in 2013, MDA determined that a redesign of the GMD kill vehicle was necessary and obtained initial concepts from Boeing, Raytheon, and Lockheed Martin on new, potential kill vehicle designs. MDA assessed those concepts and decided against conducting a full and open competition to select a single concept. Instead, MDA merged the contractors' concepts into a single, "best-of-breed" RKV design and tasked them with collaboratively developing the RKV. According to MDA, it could not perform a full and open competition because it would take too much time and the agency would not be able to meet its requirement to begin fielding RKVs in 2020—a requirement MDA established for itself. However, our assessment of internal MDA analysis indicated that when comparing schedule projections with comparable risk levels, the industry teaming approach had no significant schedule advantage over competing the RKV development effort. Moreover, recent adjustments to the RKV schedule now indicate production to begin in 2022. MDA subsequently received feedback from DOD components regarding the lack of competition present in RKV's acquisition strategy. By not addressing concerns raised by DOD's components regarding the lack of RKV competition and adjusting its acquisition strategy, MDA missed some of the potential benefits typically achieved through competition.

DOD acquisition officials also raised concerns with MDA's plan to award a full-rate production contract in advance of USD(AT&L) making the respective production decision. By doing so, MDA is at risk of creating avoidable and potentially significant financial risks for the government because activities scheduled to occur after the contract is awarded (e.g., flight testing, production, etc.) may reveal problems with the contractor's performance or the system's design, either of which may be costly to resolve. According to MDA's RKV acquisition strategy, the program plans to award a full-rate production contract in the third quarter of fiscal year 2019 and make a full-rate production decision in the second quarter of fiscal year 2020. Generally, the full-rate production decision is intended to be based on a review of the results from operational testing, initial manufacturing, and limited deployment and the USD(AT&L) is the

decision authority for MDA's production decisions, including RKV.[75] To reduce risk, MDA stated that it plans to include in the production contract a stipulation that references the successful execution of flight testing. Although stipulations such as these might mitigate some of the risks the agency faces, it is also possible that this type of contingency may increase the contractor's proposed prices due to the risks that the contractor would assume in accepting this contingency. Moreover, awarding the RKV full-rate production contract in advance of completing flight testing potentially commits the department to buying a product prior to demonstrating the system is operationally useful and may require further design changes due to knowledge learned from testing and initial production—as was the case for the current GMD kill vehicle. Because the contract award and production decision are several years out, an opportunity currently exists for MDA to modify its plans so that the full-rate production contract award occurs after the production decision so as to avoid any potential disruptions or concerns that might reduce support from key DOD decision makers.

Conclusions

MDA continues to make mixed progress in fielding additional assets and demonstrating an increased capability against emerging threats. In terms of progress, of particular significance are the delivery of BMDS level capabilities to support the presidentially mandated delivery of EPAA Phase 2 and the conduct of an operational test that demonstrated a layered BMDS with multiple combat systems sharing common defended areas and shot opportunities against two threat-representative ballistic missiles. However, the program is still operating at a self-imposed fast pace, as production and fielding of assets occurs despite the inability to thoroughly validate them due to testing delays. By adopting high-risk approaches to meet its schedule goals, MDA exacerbates the broad span of technical, engineering, and developmental challenges that already face the agency. This is especially evident in the GMD program, where MDA has continued to field GMD interceptors although testing to demonstrate its capability against an ICBM range target has been further delayed. However, continuing to deliver assets before key knowledge is obtained places MDA at risk for increased cost and schedule delays. In addition, it

[75]Department of Defense, *Missile Defense Agency*, Directive 5134.09 (2009).

reduces the warfighter's insights into the system's capabilities and limitations.

Further, the success of MDA's testing schedule hinges on it being realistic (i.e., executable) and resourced with sufficient time, funding, and reliable targets. MDA has internal scheduling policies designed to help it plan and execute tests, but some deviations and shortcomings, such as lack of a requirement to assign resources and a developed work breakdown structure, may be undermining its ability to effectively do this. Consequently, the same challenges and associated cost and schedule impacts that it has already experienced are likely to continue.

The business case for MDA's next generation efforts reflects the overall challenges the agency faces with accomplishing its unique mission to quickly develop, produce, and field first-of-its-kind military capabilities that are also affordable, reliable, and effective. MDA incorporated several elements of a sound business case for its next generation efforts, such as performing early concept exploration, maturing technologies, and promoting competition. However, the requirements for MDA' s next generation efforts are missing warfighter approval and generally reflect the needs and preferences of MDA ahead of the warfighter. In addition, the RKV acquisition strategy lacks industry competition. By not addressing concerns raised by DOD's components regarding the lack of RKV competition, MDA has missed some of the potential benefits typically achieved through competition such as reducing developmental time and reducing overall program costs. If steps are not taken to increase buy-in from DOD's warfighting and acquisition components for MDA's next generation efforts, the agency runs the risk of pursuing efforts that may be unneeded, unaffordable, ineffective, and later canceled.

Recommendations for Executive Action

We recommend that the Secretary of Defense take the following four actions to strengthen MDA's acquisition efforts and strengthen oversight.

1. To increase traceability and insight into MDA's test program, require MDA to
    a. include a detailed crosswalk of changes to each test, such as names, planned execution dates, test types, targets, and other modifications, in each iteration of its Integrated Master Test Plan;

b. address deficiencies in its test scheduling policy by better aligning it with best practices for scheduling, including the use of a schedule WBS that clearly traces each activity to the cost WBS, properly assigning resources to schedules, and clarifying guidance on when and how to conduct schedule risk analysis;

c. rectify deficiencies in its element and test level cost estimates by requiring the use of the common test WBS, documenting the traceability of source data, and codifying the processes and associated information for the software application (TRMP-T) used to create the test level cost estimates in policy; and

d. break out funding requests by test in the BAR and other budget documentation submitted during the annual budget submission.

2. To improve MDA's requirement-setting process and ensure it includes an appropriate balance between MDA and warfighter priorities, require MDA to develop a plan to transition operational requirements analysis currently performed within MDA's Achievable Capabilities List to the U.S. Combatant Commanders, with U.S. Strategic Command as the lead entity and, in the interim, require MDA to obtain their concurrence of the Achievable Capabilities List prior to its release.

3. To ensure that the RKV acquisition strategy continues to remain viable, promotes effective competition, and addresses concerns raised by DOD components, require the Director, CAPE to perform a comprehensive review of the RKV acquisition strategy and provide any recommendations to the Secretary of Defense that the Director deems necessary and appropriate to obtain CAPE's concurrence for the RKV program's acquisition strategy. Any decision to award a full-rate production contract should be delayed until after MDA has received approval from the USD(AT&L) to proceed to full-rate production.

4. To ensure that future acquisition strategies MDA develops for its new efforts reflect an appropriate balance between timeliness, affordability, reliability, and effectiveness and achieve department-wide buy-in, the Secretary of Defense should require MDA to produce acquisition strategies for all its major new efforts that are subject to review by the Director, CAPE and review and approval by the USD(AT&L).

Agency Comments and Our Evaluation

DOD provided us with written comments on a draft of this report. DOD's comments are reprinted in appendix I and are summarized below. DOD and MDA also provided technical comments, which were incorporated as appropriate.

In its comments, DOD concurred with part of our first recommendation to increase traceability and insight into MDA's testing program, but it did not concur with the remaining parts or our other three recommendations regarding improving MDA's processes for setting requirements and formulating acquisition strategies, specifically with CAPE performing a comprehensive review of the RKV acquisition strategy. As we describe below, DOD challenged several of the facts underpinning our recommendations and findings—facts that we independently corroborated and, in certain instances, re-confirmed upon receiving DOD's comments. Further, DOD cited concerns for actions that we did not include in our recommendations. For example, DOD stated in its response to our first recommendation that it disagreed with using MDA's Test Resource Mission Planning-Tool as a cost model—a recommendation we did not make. However, we modified our recommendations in three instances to address concerns that DOD cited that would prevent it from acting upon them. Those modifications are also described below.

DOD concurred with the first part of our four-part recommendation to increase traceability and insight into MDA's test program by agreeing to include a detailed crosswalk of changes to each test in the Integrated Master Test Plan (IMTP) beginning with future versions. However, it did not concur with the remaining three parts of this recommendation that include steps related to scheduling, cost, and reporting:

- **Scheduling.** DOD did not concur with our recommended steps to improve the reliability of MDA's test schedules, including clarifying when and how to conduct schedule risk analysis, using a test schedule Work Breakdown Schedule (WBS) designed to capture all of the detailed activities and easily track planned versus accomplished activities, and assigning resources to each test schedule. DOD stated that it believes the benefits do not outweigh the costs. Despite its non-concurrence, DOD noted that MDA is revising its scheduling policy to address when and how to conduct schedule risk analysis and the shortcomings in its test schedules.

DOD commented that using a test schedule WBS is cost prohibitive and only provides marginal gain over the crosswalk MDA plans to implement in its next test plan, IMTP 19.1. We disagree with DOD's comment because the test schedule WBS that we recommended and the crosswalk that MDA is planning to implement are distinct solutions to two very different issues. A test schedule WBS is a planning framework for a single test that is designed to capture all of the detailed activities and instructions in order to achieve the test's objectives and easily track the activities that have been completed versus those that are outstanding. Beyond being a framework to capture all activities and track progress, a test schedule WBS is also a means to align the schedule to the associated cost estimate (i.e., budget), and enables actual costs to be incorporated back into the test cost estimate to understand correlations between the schedule and costs, such as the effects from schedule adjustments or slippages. In contrast, a crosswalk traces changes that have already occurred to each test over time (e.g., test name, execution date, test type, and target type). Each provides a means for tracking tests, but with discrete purposes at different points in time and thus, are not interchangeable—one does not suffice in lieu of the other. Currently, MDA's scheduling policy requires schedule activities to align with the cost estimate, but the policy does not detail how to ensure this alignment. Misaligned test schedules and cost estimates can lead to unknown scope and expenses, under- or over-allocated resources, and unrealistic test execution dates. We believe it is reasonable to conclude that the lack of a test schedule WBS is a contributing factor for MDA consistently falling short of its testing goals each year and the unclear cost implications for doing so. Thus, we maintain our position that using a test schedule WBS would improve the reliability of test schedules and increase insight.

DOD also stated that MDA's current approach for assigning resources to tests, which includes high-level reviews and planning meetings prior to the test's execution, is adequate. In concept, MDA's current approach appears to be dynamic, allowing it to assign and use resources at the point when they are needed; however, in practice, MDA often needs resources well in advance of the test execution which means costs are being accrued without being assigned to a specific test. Consequently, when MDA delays or removes a test, those costs may be unaccounted for. Further, a test schedule without assigned resources implies that an unlimited amount and availability of resources exist. Considering MDA's test record, which is constantly in flux, there could be questions about the intentions of its approach.

We acknowledge that assigning resources to schedules may be challenging in some instances; however, it is a critical step when creating a schedule because it: (1) confirms that the timeframes of activities are realistic and rational; (2) helps calculate and resolve resource conflicts; and (3) ensures that resources are available when they are needed.

- **Costs.** DOD did not concur with steps to improve consistency and transparency in MDA's test costs that align with best practices for internal controls and cost estimating.[76] Specifically, we recommended that MDA codify its processes and information in policy for the Test Resources Mission Planning-Tool (TRMP-T), a classified application used to create test level cost estimates that support its budget request each fiscal year. DOD did not address this recommendation but, instead, commented that it did not agree with our recommendation to use TRMP-T as a cost model. We did not recommend that TRMP-T be used as a cost model, nor was it our intent for MDA to do so. It is our understanding that MDA is already using TRMP-T as a cost model. Specifically, information we received from senior MDA officials and various documents we reviewed indicate TRMP-T is a cost model and that MDA is using it as such. For example, in February 2014, an independent contractor providing support to MDA assessed the software application used to create MDA's test-level estimates and identified a number of shortcomings, including, among other things, the need to document it in policy. DOD contends, however, that TRMP-T is not a cost model but rather an integration and reporting tool for test costs and other test information, such as requirements and resources. If it were simply an integration and reporting tool, the costs in the element level cost estimates would mirror those in TRMP-T for each test, but as we found and have said in this report, the costs consistently varied from those in TRMP-T.

  Furthermore, DOD's rationale for not concurring with our recommendation is that MDA's current processes align with best practices for cost estimating and therefore do not need to be modified. However, our recommendation was based on numerous deficiencies we identified during our assessment of MDA's current policies and processes against best practices. We stand by our conclusion that because MDA's test level estimates from TRMP-T are used as the basis for the budget request and to inform decision makers, they

[76] GAO-14-704G and GAO-09-3SP.

should encompass all of the best practice characteristics to be reliable, which include using a common test estimate WBS to capture costs and documenting the traceability of source data.

- **Reporting.** To increase transparency into MDA's test costs, we recommended that it break out its funding requests by test in the BAR and other budget documentation each year. DOD did not concur with our recommendation under the rationale that it is unrealistic and that there is no requirement to do so. MDA has consistently fallen short of its test goals, which has led to frequent changes to tests without identifying the corresponding effects to its costs and funding needs, despite our prior recommendation to do so.[77] Specifically, the frequent changes and lack of transparency have created challenges for identifying how many times or how much funding MDA has requested, received, and obligated per test each fiscal year and across multiple fiscal years. The transparency of testing costs has been a particular concern for Congress. For example, the National Defense Authorization Act for Fiscal Year 2017 requires MDA to submit a notification to congressional defense committees that includes, among other things, costs by test, at least once every 180 days (i.e., twice per year).[78] We therefore maintain that breaking out funding requests by test will improve transparency into planned versus actual test costs and aid departmental and congressional decision makers as they make difficult choices of where to invest limited resources.

DOD did not concur with our second recommendation to require MDA to develop a plan to transition requirements analysis currently performed in MDA's ACL to JFCC IMD and, in the interim, require MDA to obtain JFCC IMD's concurrence of the ACL prior to its release. In its response, DOD stated our recommendation was based on conclusions drawn from information that does not accurately represent the missile defense requirement-setting process. DOD contends that the warfighter, rather than MDA, leads the process for generating, validating, and approving missile defense requirements through generation of the PCL. However, DOD also stated in its description of the process that the ACL addresses each item in the PCL and informs the warfighter on how, when, and if those capabilities can or will be delivered. In addition, MDA's acquisition instruction states that the results of ACL are translated into BMDS

[77]GAO-11-372.

[78]National Defense Authorization Act for Fiscal Year 2017, Pub. L. No. 114-328 § 1695 (2016).

system-level requirements. As such, while the PCL identifies warfighter needs, the ACL, rather than the PCL, leads to specific program-level requirements and programmatic specifications. As we found in our review, the process as it currently functions places an undue emphasis on the needs of MDA ahead of the warfighter. In response to DOD's assertions that we did not accurately represent the process, we consulted with both JFCC IMD and U.S. Northern Command—key components of the warfighter community—and both concurred that our assessment of the requirements-setting process was accurate. We maintain that while the warfighter currently plays an important role in providing input into MDA's requirements-setting process, it has not been provided with the responsibility of establishing operational requirements to which MDA must adhere. Instead, MDA decides which requirements it will pursue, from operational to system-specific requirements.

DOD also stated in its response to this recommendation that the requirements analysis performed in the ACL is an inherently acquisition-related function and, therefore, inappropriate for the warfighter to perform. Moreover, the response stated that JFCC IMD does not have the skill sets, nor the engineering simulations and models to perform this type of requirements analysis. DOD's response conflates the technical and engineering expertise that MDA, as the material developer, brings to bear on the requirements-setting process with the operational expertise brought to bear by the warfighter as being one and the same. The warfighter's expertise is based on decades of experience gained from operating missile defense platforms and its understanding of the capabilities and limitations of these systems. In addition, although DOD stated in its response that JFCC IMD currently lacks the engineering simulations and models needed to perform such requirements analyses, it did not explain why these assets could not be transitioned to the warfighter or why the warfighter would or should not be able to access these tools. During subsequent discussions with DOD officials regarding our recommendation, some officials were unfamiliar with JFCC IMD's role, responsibilities, and utility in advocating warfighter needs. To provide clarity, we revised our recommendation to identify the U.S. Combatant Commands, with U.S. STRATCOM as the lead entity that should take responsibility for setting operational requirements for missile defense capabilities, as opposed to JFCC IMD. We also clarified that our recommendation is aimed at transitioning operational requirements to the warfighter so that the responsibility for generating system-specific requirements remains with MDA.

We also acknowledge that MDA has a valid and appropriate role in the requirements-setting process and that the current process has afforded MDA a level of flexibility to respond to requests from senior leaders. We also agree that MDA's requirements-setting process currently provides a significant amount of warfighter involvement, that MDA has demonstrated responsiveness to warfighter needs, and that the interests of both groups are not mutually exclusive. Indeed, both have a vested interest in seeing that new capabilities are fielded as quickly as feasible. However, our findings indicate that an imbalance exists in the current requirements-setting process regarding MDA's ability to establish operational requirements, rather than the warfighter. Specifically, DOD has opted to continue to rely upon the contractors, program managers, and senior executives at MDA to perform the task of determining operational requirements—a task that JFCC IMD contends is best suited for the men and women experienced in defending the United States from ballistic missile attacks. We believe that our recommendation would provide the warfighter with this responsibility.

DOD also did not concur with our third recommendation for the Director, CAPE to perform a comprehensive review of the RKV acquisition strategy and delay any decision to award a full-rate production contract until after MDA has received approval from the USD(AT&L) to proceed with full-rate production. In its response, DOD stated that the Joint Staff, the OSD staff, and CAPE conducted a comprehensive review of the RKV acquisition strategy before the USD(AT&L) approved the strategy. We agree with DOD that the strategy was reviewed by several organizations and that the USD(AT&L) ultimately approved the strategy. However, CAPE, along with several other organizations, raised serious concerns about the program's design, development method, schedule, and cost, and did not fully agree with the strategy. As we noted in our report, MDA did not obtain CAPE's concurrence on the strategy and CAPE officials continue to voice serious concerns with the strategy. While MDA received the senior leadership approval it was required to obtain, we found that MDA did not build consensus and support across the department for the RKV acquisition strategy. As indicated in our report, the lack of stakeholder buy-in can be a key driver for program cancellation, and, as such, DOD should take the steps necessary to ensure that such buy-in exists across the department for how MDA plans to acquire the RKV. We believe this can be accomplished, in part, by having CAPE perform a comprehensive review and make recommendations to the Secretary of Defense regarding any changes CAPE determines are necessary to gain it's concurrence of the strategy.

In its response, DOD also stated that our recommendation would require a change in CAPE's statutorily defined responsibilities. We do not believe any such changes are needed for DOD to implement our recommendation. We also consulted with a representative from the Office of the Secretary of Defense's Office of General Counsel, who agreed that no legal barriers to implementing our recommendations exist.

In addition, as we stated in our report, there is precedent for CAPE performing studies similar to what we recommend. For example, CAPE previously conducted a comprehensive review of the Precision Tracking Space System. As we reported in 2013, the study included an analysis of the program's cost, schedule, technical design, and acquisition strategy, which resulted in a group of senior DOD officials presenting options to the Secretary of Defense in response to the study's findings.[79] We believe this 2013 CAPE study of the Precision Tracking Space System would be an appropriate model for an RKV comprehensive review, as we recommend in our report.

DOD did not substantively address the second part of our recommendation regarding delaying any decision to award a full-rate production contract until cleared by the USD(AT&L). In its response, DOD cited current departmental policy regarding the USD(AT&L)'s authority in approving decisions for programs to proceed to full-rate production, including RKV. DOD did not acknowledge the concerns we raised in our report, nor did it state whether or not it concurred with our recommendation to delay any full-rate production contract award until the USD(AT&L) approved proceeding to full-rate production. However, recent GMD program plans indicate the agency is still planning to award a full-rate contract for new GMD interceptors that include the RKV in advance of the RKV's full-rate production decision. As we note in our report, MDA runs the risk of creating avoidable and potentially significant financial risks to the government because activities scheduled to occur after the contract is awarded may reveal costly problems that the government failed to consider at the time the contract was awarded. In order to ensure departmental approval and oversight and to reduce the financial risks, we continue to maintain that DOD should delay any decision to award a full-rate production contract for RKV until after the USD(AT&L) has approved the program to proceed with full-rate production.

[79]GAO-13-747R.

Lastly, DOD did not concur with our fourth recommendation that the Secretary of Defense should require MDA to produce acquisition strategies for all its major new efforts that are subject to review and approval from the Director, CAPE and USD(AT&L). In its response, DOD stated that under current DOD policy, the Director, MDA is responsible for BMDS development and acquisition strategies and must only obtain USD(AT&L) approval for production-related decisions. DOD also noted that the recommendation would require changes to CAPE's statutorily defined responsibilities. We disagree that such a change is needed to implement the recommendation and when we consulted with an official from the Office of the Secretary of Defense's Office of General Counsel, the official agreed that no legal barriers exist that would prevent the Secretary of Defense from directing CAPE or USD(AT&L) to review and approve MDA's future acquisition strategies.

The intent of our recommendation was to leverage the unique expertise that the many components across DOD have to offer to ensure MDA's acquisition strategies are robust, risk-balanced, and supported across the department. After reviewing DOD's comments, we revised the recommendation to clarify that it is focused on MDA's acquisition strategies that would be subject to CAPE's review, and not approval, so as to preserve CAPE's intended role of serving as an independent advisor to the Secretary of Defense rather than acting as a decision authority.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, and to the Director, MDA. 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 about this report, please contact me at (202) 512-4841 or chaplainc@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix X.

Cristina Chaplain
Director, Acquisition and Sourcing Management

List of Committees

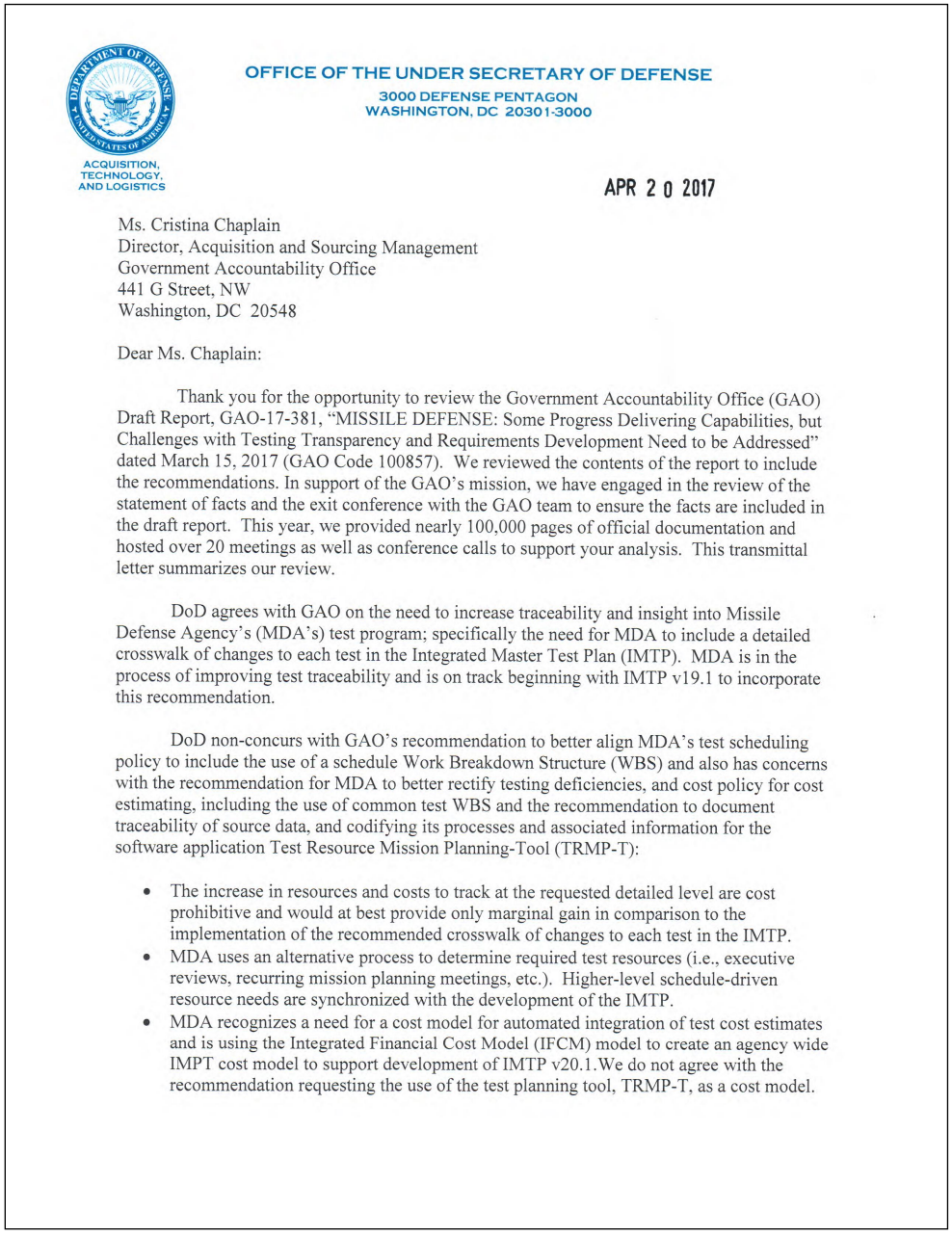
The Honorable John McCain
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Thad Cochran
Chairman
The Honorable Richard Durbin
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Mac Thornberry
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Kay Granger
Chairwoman
The Honorable Pete Visclosky
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Comments from the Department of Defense



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

ACQUISITION, TECHNOLOGY, AND LOGISTICS

APR 2 0 2017

Ms. Cristina Chaplain
Director, Acquisition and Sourcing Management
Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Ms. Chaplain:

Thank you for the opportunity to review the Government Accountability Office (GAO) Draft Report, GAO-17-381, "MISSILE DEFENSE: Some Progress Delivering Capabilities, but Challenges with Testing Transparency and Requirements Development Need to be Addressed" dated March 15, 2017 (GAO Code 100857). We reviewed the contents of the report to include the recommendations. In support of the GAO's mission, we have engaged in the review of the statement of facts and the exit conference with the GAO team to ensure the facts are included in the draft report. This year, we provided nearly 100,000 pages of official documentation and hosted over 20 meetings as well as conference calls to support your analysis. This transmittal letter summarizes our review.

DoD agrees with GAO on the need to increase traceability and insight into Missile Defense Agency's (MDA's) test program; specifically the need for MDA to include a detailed crosswalk of changes to each test in the Integrated Master Test Plan (IMTP). MDA is in the process of improving test traceability and is on track beginning with IMTP v19.1 to incorporate this recommendation.

DoD non-concurs with GAO's recommendation to better align MDA's test scheduling policy to include the use of a schedule Work Breakdown Structure (WBS) and also has concerns with the recommendation for MDA to better rectify testing deficiencies, and cost policy for cost estimating, including the use of common test WBS and the recommendation to document traceability of source data, and codifying its processes and associated information for the software application Test Resource Mission Planning-Tool (TRMP-T):

- The increase in resources and costs to track at the requested detailed level are cost prohibitive and would at best provide only marginal gain in comparison to the implementation of the recommended crosswalk of changes to each test in the IMTP.
- MDA uses an alternative process to determine required test resources (i.e., executive reviews, recurring mission planning meetings, etc.). Higher-level schedule-driven resource needs are synchronized with the development of the IMTP.
- MDA recognizes a need for a cost model for automated integration of test cost estimates and is using the Integrated Financial Cost Model (IFCM) model to create an agency wide IMPT cost model to support development of IMTP v20.1.We do not agree with the recommendation requesting the use of the test planning tool, TRMP-T, as a cost model.

TRMP-T was developed to support test planning and requirements collecting aggregate cost.

DoD also non-concurs with the recommendation to breakout funding requests by test in the BMDS Accountability Report (BAR) and other budget documentation. Title 10 USC 225 directs that MDA submit the BAR yearly to report on component program baselines across 6 areas (Resource, Schedule, Technical, Test, Contract, and Operational Capacity) and specifically directs in the language to track costs versus funding requests for resource reporting. Since tests cross multiple programs, the BAR is not the appropriate document to report test costs.

DoD non-concurs with the recommendation regarding the warfighter capabilities process. This recommendation is based on conclusions drawn from information that does not accurately represent the capability requirements process that exists between US Strategic Command and MDA. MDA's responses in the technical comments submitted to GAO by our Primary Action Officer provide information that accurately describes that process.

DoD also non-concurs with recommendations for the Director, Cost Analysis and Performance Evaluation (CAPE) to review and concur on MDA's RKV Acquisition Strategy, and also for the Director, CAPE to approve MDA acquisition strategies for all new major efforts. The CAPE is responsible for providing unbiased analysis on resource allocation and cost estimation problems to the Secretary of Defense along with reviewing, analyzing, and evaluating programs execution of approved acquisition strategies and policies and ensuring that information on programs is presented accurately and completely. While CAPE's input may influence production decisions or production related decisions for missile defense related assets, in accordance with Deputy Secretary of Defense approved Department of Defense Directive (DoDD) 5134.09, the Director, MDA is the Acquisition Executive responsible for Ballistic Missile Defense System (BMDS) development, and acquisition strategies. As such, the MDA Director obtains USD (AT&L) approval for production-related decisions.

Detailed comments on the draft GAO report recommendations are enclosed. We appreciate the opportunity for close collaboration with your staff. My point of contact for this effort is Mr. Robert Thomas, e-mail: robert.l.thomas516.civ@mail.mil, and phone number 703-571-1780.

Sincerely,

Dyke Weatherington
Performing the Duties of the
Assistant Secretary of Defense (Acquisition)

Enclosures:
As stated

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GAO DRAFT REPORT RELEASED MARCH 15, 2017
GAO-17-381 (GAO CODE 100857)

"MISSILE DEFENSE: SOME PROGRESS DELIVERING CAPABILITIES, BUT CHALLENGES WITH TESTING TRANSPARENCY AND REQUIREMENTS DEVELOPMENT NEED TO BE ADDRESSED"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATION

The GAO recommends that the Secretary of Defense take the following four actions to strengthen MDA's acquisition efforts and strengthen oversight.

RECOMMENDATION 1: To increase traceability and insight into MDA's test program, require MDA to:

a. Include a detailed crosswalk of changes to each test, such as names, planned execution dates, test types, targets, and other modifications, in each iteration of its Integrated Master Test Plan.

b. Address deficiencies in its test scheduling policy by better aligning it with best practices for scheduling, including the use of a schedule WBS that clearly traces each activity to the cost WBS, properly assigning resources to schedules, and clarifying guidance on when and how to conduct schedule risk analysis;

c. Rectify deficiencies in its cost policy by better aligning it with best practices for cost estimating, including requiring the use of the common test WBS, documenting the traceability of source data, and codifying its processes and associated information for it software application (TRMP-T) used for creating the test-level cost estimates in policy; and

d. Breakout funding requests by test in the BAR and other budget documentation submitted during the annual budget submission.

DoD RESPONSE: DoD concurs with recommendation 1.a. DoD does not concur with recommendations 1.b., 1.c., and 1.d.

For recommendation 1.a., MDA is in the process of improving test traceability and is on track beginning with IMTP version 19.1. MDA will implement improvements in reporting test program changes to Congress, including providing a detailed crosswalk of changes to individual tests compared to the previous IMTP version submitted to Congress.

For Recommendation 1.b., MDA does not use common schedule WBS or resource loaded Government schedules for programs, elements, or individual tests. The increase in resources and costs to track at the requested detailed level would at best provide only marginal gain in comparison to the implementation of the recommended crosswalk of changes to each test in the

IMTP. The MDA uses a carefully tailored process to determine required test resources (i.e. executive reviews, recurring mission planning meetings). Higher-level schedule-driven resource needs are synchronized during development of the IMTP. DoD has determined that this approach is adequate to effectively assign and track resources assigned to testing.

MDA is working to improve individual flight and ground test schedules to better meet MDA scheduling policy, which is fundamentally based on the GAO scheduling best practices as well as revise its scheduling policy documentation to address how and when to conduct schedule risk analysis.

For recommendation 1.c., the MDA uses established best practices in developing test cost estimates. MDA has vetted its procedures and documentation with the GAO. DoD does not agree with the recommendation to use the test planning tool, TRMP-T, as a cost model. TRMP-T was developed to support test planning and requirements by collecting aggregate cost. MDA recognizes a need for a cost model for automated integration of test cost estimates and is using the Integrated Financial Cost Model (IFCM) model to create an agency wide IMPT cost model to support development of IMTP v20.1.

For recommendation 1.d., the DoD non-concurs with the recommendation to breakout funding requests by test in the BDMS Accountability Report (BAR) and other budget documentation. Title 10, United States Code section 225 directs MDA to submit the BAR yearly to include component program baselines of schedule, technical, cost, and test, and specifically directs in the language to track costs versus funding requests for resource reporting. Regarding other budget documentation, testing by nature is a dynamic process with multiple test events planned across multiple years; thus, an 18-24 month process to develop an annual budget makes this an unrealistic recommendation to submit budget documentation by test event.

The MDA provides the data requested in accordance with National Defense Authorization Act (NDAA) for Fiscal Year 2017, Public Law 114-328 §1695, which requires the Director, MDA to submit a semiannual notification on missile defense tests and costs. This notification includes "test costs…funds expended on such attempted test," and is the appropriate documentation to increase traceability and insight into MDA's test program. To address the GAO's recommendation, this data can be provided to the GAO concurrently with the Congressional reporting requirement.

RECOMMENDATION 2: To improve MDA's requirement-setting process and ensure it includes an appropriate balance between MDA and warfighter priorities, require MDA to develop a plan to transition requirements analysis currently performed with in MDA's Achievable Capabilities List to the Joint Functional Component Command for Integrated Missile Defense, and, in the interim, require MDA to obtain their concurrence of the Achievable Capabilities List prior to its release.

DoD RESPONSE: DoD non-concurs. This recommendation appears to be based on conclusions drawn from information that does not adequately or sufficiently represent the capability requirements process that exists between U.S. Strategic Command and the MDA. MDA assesses U.S. Strategic Command's Integrated Air and Missile Defense Prioritized Capabilities List

(PCL) and, considering timeframe, realistic technology, and resource availability, documents its analysis in an Achievable Capabilities List (ACL). This assessment is a systems engineering function within the MDA acquisition process. Not only does the Joint Functional Component Command for Integrated Missile Defense (JFCC-IMD) not have the skill sets, engineering simulations, and models to perform this type of requirements analysis, it would be inappropriate for JFCC-IMD to perform this inherently acquisition function as suggested by this recommendation. The MDA has provided information that correctly and appropriately describes the capability-based requirements process, warfighter participation in the systems engineering of materiel solutions, and the validation and governance processes that are used extensively to provide missile defense capabilities to the warfighter.

U.S. Strategic Command (STRATCOM) leads the generation, validation, and approval of warfighter ballistic missile defense capability requirements. The MDA interacts with U.S. STRATCOM as well as the other Combatant Commands, JFCC-IMD, Joint Staff, the test community to include the Director Operational Test and Evaluation (DOT&E), and the Office of the Secretary of Defense (OSD) staff during the requirements generation, engineering review, assessment and test planning, test execution and results briefings, and deployment decision meetings. Representatives from these organizations attend many of the working-level and executive decision meetings, resulting in ample verbal and written input from the Warfighter.

RECOMMENDATION 3: To ensure that the RKV acquisition strategy continues to remain viable, promotes effective competition, and addresses concerns raised by DOD components, require the Director, CAPE to perform a comprehensive review of the RKV acquisition strategy and provide any recommendations to the Secretary of Defense that the Director deems necessary and appropriate to obtain CAPE's concurrence for the RKV program's acquisition strategy. Any decision to award a full-rate production contract should be delayed until after MDA has received approval from the USD(AT&L) to proceed to full-rate production.

DoD RESPONSE: DoD non-concurs. The Joint Staff, the OSD staff, and CAPE conducted a comprehensive review of the RKV acquisition strategy before the USD(AT&L) approved it on October 8, 2015. In accordance with DoDD 5134.09, USD(AT&L) is the approval authority for all MDA production decisions, including RKV. Title 10, United States Code section 139c, provides that the Director of Cost Assessment and Program Evaluation (CAPE) is responsible for 1) ensuring the Department's cost estimation and cost analysis processes provide accurate information and realistic estimates of cost for the major acquisition programs, and 2) for reviewing, analyzing, and evaluating program execution of approved acquisition strategies and policies, and ensuring that information on programs is presented accurately and completely. Thus, CAPE provides unbiased analysis on resource allocation and cost estimation problems to the Secretary of Defense, however, CAPE's concurrence is not required for acceptance and approval of an acquisition strategy. Further, Title 10, United States Code section 2431a, which establishes the requirements for acquisition strategies, does not require CAPE approval of acquisition strategies. While CAPE's input may influence production decisions or production related decisions for missile defense related assets, in accordance with Deputy Secretary of Defense DoDD 5134.09, the Director, MDA is the Acquisition Executive and is responsible for BMDS development, and acquisition strategies. This recommendation would require a change in

the CAPE's mission, statutorily defined responsibilities, and possibly require a potential change to processes for all acquisition programs across the department.

RECOMMENDATION 4: To ensure that future acquisition strategies MDA develops for its new efforts reflect an appropriate balance between timeliness, affordability, reliability, and effectiveness and achieve department-wide buy-in, the Secretary of Defense should require MDA to produce acquisition strategies for all its major new efforts that are subject to review and approval by the Director, CAPE and the USD(AT&L).

DoD RESPONSE: DoD non-concurs. While CAPE's input may influence production decisions or production related decisions for missile defense related assets, in accordance with Deputy Secretary of Defense DoDD 5134.09, the Director, MDA is the Acquisition Executive and is responsible for BMDS development, and acquisition strategies. As such, the MDA Director must only obtain USD (AT&L) approval for production-related decisions. Title 10, United States Code section 139c, provides that the Director of Cost Assessment and Program Evaluation (CAPE) is responsible for ensuring the Department's cost estimation and cost analysis processes provide accurate information and realistic estimates of cost for the major acquisition programs along with reviewing, analyzing, and evaluating programs execution of approved acquisition strategies and policies and ensuring that information on programs is presented accurately and completely. This recommendation would require a change in the CAPE's mission, statutorily defined responsibilities, and department processes for all acquisition programs across the department.

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Appendix II: Aegis Ballistic Missile Defense (BMD) Weapons System

Figure 11: Aegis Ballistic Missile Defense Appendix II

Key Findings for Fiscal Year 2016

- Aegis BMD program supported the European Phased Adaptive Approach (EPAA) Phase 2 but with less capability than planned.
- Aegis Weapon System continued its efforts to increase capability for defense of the United States.
- Aegis Weapon System upgrades for EPAA Phase 3 could be at schedule risk.

Source: Missile Defense Agency (MDA) and GAO Analysis of MDA Data. | GAO-17-381

Program Overview

Aegis Ballistic Missile Defense is the naval component of the Missile Defense Agency's (MDA) Ballistic Missile Defense System. It consists of the Aegis Ballistic Missile Defense Weapon System (AWS), including a radar, and Standard Missile-3 (SM-3) interceptors.

MDA is developing the AWS in versions called spirals that expand on preceding capabilities. Deliveries of the spirals are planned to support MDA's Phased Adaptive Approach (PAA)—a set of BMDS level capabilities designed to defend specific geographic regions—including the European PAA (EPAA)— in the December 2015 and 2018 time frame. In December 2015, in support of EPAA Phase 2, MDA delivered an upgrade for ships called Aegis AWS 5.0 Capability Upgrade (5.0CU) and the land based Aegis Ashore, although with less than planned testing.[1] In addition, MDA is developing Aegis BMD capability to improve discrimination and capability to support defense of the United States known as Near-Term Discrimination Improvements for Homeland Defense. For specifics on Aegis Ashore and the Aegis SM-3 interceptors,

[1] Aegis AWS 5.0CU expands the battle-space and raid size capability and improves performance against medium and intermediate range threats. It also expands capability to intercept threats in the late phase of flight.

see appendixes III, IV and V, respectively. Table 7 provides key fiscal year 2016 AWS program facts.

Table 7: Aegis Ballistic Missile Defense (BMD) Program Facts

Major Assets Delivered Fiscal Year 2016

Aegis Weapon System 5.0 Capability Upgrade for ships and land based Aegis Ashore was delivered in December 2015.

Fiscal Year 2016 Flight Test Performance

Test Name	Test Date	Test Result
FTO-02 Event 2a	November 2015	Success
FT0-02 Event 1a	December 2015	Success

Source: GAO analysis of Missile Defense Agency data | GAO-17-381

Aegis BMD program supported EPAA Phase 2 in December 2015, but with less capability than planned

The Aegis BMD program supported the European Phased Adaptive Approach (EPAA) Phase 2 delivery in December 2015 with the delivery of AWS 5.0CU. However, another spiral that was part of the original concept was delayed. EPAA Phase 2 capability was supported, in part, by two BMDS level operational flight tests called Flight Test Operational (FTO)-2 Event 1a and FTO-02 Event 2a. While MDA experienced challenges in fiscal year 2015 with the initial attempts at both tests, once conducted, they demonstrated AWS capabilities, allowing EPAA Phase 2 declared delivered.[2] Specifically:

[2]A Technical Capability Declaration memo is the final step in MDA's process for delivering a BMDS level capability for operational use and is issued by the Director, MDA. The memo describes how the capabilities were assessed and the ability of the system to meet technical specifications. It indicates readiness for warfighter's assessment of the system's operational utility.

- MDA successfully conducted FTO-02 Event 1a in December 2015. In the test, the Aegis Ashore test installation in Hawaii engaged an air-launched medium range target with the upgraded Aegis BMD Standard Missile (SM)-3 Block IB interceptor using data from the collocated off board radar. The initial test attempt in June 2015—FT0-02 Event 1—failed after a new intermediate-range target malfunctioned. As we previously reported, the delay between the initial test and the retest reduced the time available to assess all aspects of performance prior to the Romania site delivery.[3] In addition, although the system intercepted the target, the Aegis Ashore installation was not equipped with operational version of the planned software known as AWS Baseline 9.B1, which reduced the extent the test reflected the operational architecture.
- MDA conducted FTO-02 Event 2a, in November 2015. The test was designed to demonstrate a layered BMDS with Aegis BMD and Terminal High-Altitude Area Defense (THAAD) sharing common defended areas and shot opportunities against two threat-representative ballistic missile targets. The primary Aegis BMD test objective was to conduct a ballistic missile engagement in the presence of debris generated by a THAAD intercept, while simultaneously conducting anti-air warfare against an anti-ship cruise missile target. Although the Aegis ship successfully engaged the cruise missile, the Aegis BMD SM-3 Block IB failed in flight, preventing an intercept of the ballistic missile target.[4] Moreover, according to the Director, Operational Test and Evaluation, the scenario with two Aegis targets was less stressing than prior test of similar capabilities. However, despite the Aegis BMD SM-3 Block IB failure, THAAD intercepted the target, MDA was able to collect important data on AWS tracking and engagement processing performance. For further details on the Aegis BMD SM-3 Block IB and THAAD programs, see appendix IV and IX.

Both upgraded software packages— Baseline 9.B1 and 9.C1— offer advanced defense capabilities and integration capability with other systems external to the Aegis ships. However, according to MDA officials both versions required updates, after the EPAA Phase 2 delivery, which

[3]*Missile Defense: Ballistic Missile Defense System Testing Delays Affect Delivery of Capabilities,* GAO-16-339R (Washington, D.C.: Apr. 28, 2016).

[4]A failure review board determined a component in the guidance section failed resulting in the failure. The program addressed the problem by implementing improved screening and testing of the part prior to being installed onto the interceptor. The new process changes were implemented and successfully flown in a controlled test flight.

were certified July 2016. Additionally, according to DOT&E, testing of Baseline 9.B1 indicated that the weapons system has software issues, which lowers its reliability and availability.

Additional AWS upgrades initially planned for EPAA Phase 2 now planned through December 2020

In fiscal year 2016, Aegis BMD continued to assess options for developing AWS 4.1, which was initially planned to provide ballistic missile defense capabilities for additional ships. Specifically, the upgrade was initially planned to be retrofitted on ships, especially those planned for EPAA Phase 2 as ships equipped with Baseline 9.C1 were slated for other regions. However, the effort was put on hold last year, following development challenges and program funding issues. For example, as we reported in May 2015, technical assessments revealed challenges with matching Baseline 9.C1 performance characteristics on ships which utilize older hardware.[5] This year however, MDA continued to explore options to deliver this capability, but not in support of EPAA Phase 2. Rather, current plans indicate full delivery in December 2020.

Aegis Weapon System continued its efforts to increase capability for defense of the United States

Aegis BMD also participated in two key BMD system-level assessments for the delivery of discrimination upgrades for Homeland Defense. The tests, called Ground Test Integrated -06 Part 2 and Ground Test Distributed -06 Part 2, employed models and simulations to assess upgraded AWS software— including AWS 4.0.3 and AWS 3.6.3. The new software is designed to provide upgrades for discrimination and interoperability with other BMDS elements. According to MDA, the tests successfully demonstrated the upgrades but analysis delayed the delivery of the associated capability planned for March 2017.

[5]GAO, *Missile Defense: Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities,* GAO-15-345 (Washington, D.C.: May 6, 2015).

AWS upgrades for EPAA Phase 3 could be at schedule risk

Aegis BMD made progress in development of AWS 5.1 for Aegis ships (Baseline 9.C2) and Aegis Ashore (Baseline 9.B2). AWS 5.1 improves AWS 5.0CU capability against longer range and more complex threats in the middle and terminal phases of flight. It also extends defended areas by engaging threats based on tracks from forward-based sensors. These AWS versions, expected to be delivered in December 2018, are slated to support EPAA Phase 3 and defend against intermediate range ballistic missile attacks.

However, the program schedule to meet EPAA Phase 3 lacks margins and has risk. For example, the deliveries of AWS Baseline 9.C2 and 9.B2 are now planned at the beginning of EPAA Phase 3 integration activities, leaving no time to rectify challenges that could still arise during development. Moreover, communication upgrades for this AWS version, are now behind schedule. Program documentation indicates that the lag in development could result in compatibility issues between these upgrades with the rest of the weapons system. This, in turn, could require retrofits and reduce performance. In addition, C2BMC delays deferred completion of Aegis BMD's capability to intercept threats based on tracks from forward-based sensors until fiscal year 2021. For further details on C2BMC, see appendix VI.

Appendix III: Aegis Ashore

Figure 12: Aegis Ashore Appendix III

Key Findings for Fiscal Year 2016

- MDA delivered the Aegis Ashore site in Romania with limited testing.
- Delays completing the Aegis Ashore Romania site have compressed the schedule for Aegis Ashore in Poland.

Source: Missile Defense Agency (MDA) and GAO Analysis of MDA Data. | GAO-17-381

Program Overview

Aegis Ashore is a land-based, or ashore, version of the ship-based Aegis Ballistic Missile Defense (BMD). Aegis Ashore is designed to track and intercept ballistic missiles in the middle of their flight using Aegis BMD Standard Missile-3 (SM-3) interceptors. Key components include a vertical launching system, interceptors, and an enclosure, referred to as a deckhouse, that contains the SPY-1 radar and command and control system.

Aegis Ashore will share many components with the sea-based Aegis BMD and will use future versions of the Aegis weapon system currently in development. The Missile Defense Agency (MDA) plans to equip Aegis Ashore with a modified version of the Aegis weapon system software that will share many components with the sea-based Aegis BMD. MDA deployed an operational site in Romania in fiscal year 2016 and plans an operational site in Poland in the 2018 time frame.[1] Both operational sites are being deployed to provide additional coverage for the defense of Europe.

In addition, DOD deployed a test facility in Hawaii in April 2014. The test facility will be used to flight test Aegis Ashore, and in some cases, Aegis

[1]DOD has awarded contracts for the construction and installation of the Poland facility and construction is underway.

BMD SM-3 interceptors, as upgrades become available. For further details on the Aegis Weapon System and Aegis BMD interceptors,

see appendixes II, IV and V. Table 8 provides key fiscal year 2016 Aegis Ashore Program Facts.

Table 8: Aegis Ashore Program Facts

Major Assets Delivered Fiscal Year 2016

Operational facility in Romania delivered in December 2015

Fiscal Year 2016 Flight Test Performance

Test Name	Test Date	Test Result
AA CTV-02	December 2015	Success (non-intercept flight test to prepare for FTO-02 Event 1a)
FTO-02 Event 1a	December 2015	Success

Source: GAO analysis of Missile Defense Agency data | GAO-17-381

MDA delivered the Aegis Ashore site in Romania, though with limited testing

MDA delivered the Aegis Ashore facility in Romania to support the European Phased Adaptive Approach Phase 2 declaration in December 2015, after demonstrating performance with only one intercept test.[2] As we have previously reported, insufficient testing while fielding assets increases the risk of performance shortfalls and increased costs if issues are discovered as a result of flight testing.[3] In December 2015, MDA conducted a BMDS level flight test—FTO-02 Event 1a—intended to demonstrate the operational capability of EPAA Phase 2 and Aegis Ashore's ability to defend Europe against medium-range ballistic threats.

[2] European PAA (EPAA) is DOD's plan to deploy regional BMD capabilities in Europe. EPAA is part of U.S. policy. See GAO, *Missile Defense: Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities,* GAO-15-345 (Washington, D.C.: May 6, 2015).

[3] GAO, *Missile Defense: Opportunity Exists to Strengthen Acquisitions by Reducing Concurrency*, GAO-12-486 (Washington, D.C.: Apr. 20, 2012).

In the test, the Aegis Ashore Missile Defense test facility successfully engaged an air-launched medium-range target with an upgraded Aegis BMD SM-3 Block IB interceptor.

FT0-02 Event 1a was Aegis Ashore's first and only intercept test prior to declaring the site operational. Moreover, since 2013, Aegis Ashore has reduced the number of planned intercept tests prior to EPAA Phase 3 from four to two. According to program officials, they are leveraging data from sea-based Aegis BMD tests, however, conditions at sea are different than on land, as are the system configurations. While MDA delivered Aegis Ashore in Romania, incomplete test data delayed the evaluation of Aegis Ashore's performance against all expected engagement scenarios to determine its capabilities and limitations. This analysis is not expected to be completed until at least fiscal year 2018.

Delays completing the Aegis Ashore Romania site pose challenges for construction of the Aegis Ashore in Poland

Construction of the Aegis Ashore site in Poland, the schedule for which has already been compressed, has been further complicated due to delays in completing work at the site in Romania. The Romanian site's late finish and the Poland site's slow start has resulted in the Aegis Ashore program concurrently working on both sites, leading to the increased risk of schedule delays or reduced testing. Aegis Ashore program documentation indicated that all work on the Aegis Ashore site in Romania was to be complete by December 2015; however work will be ongoing until at least fiscal year 2017 due to, among other things, the necessity to resolve power system issues required to complete system verification and validation. Overseeing work at two sites simultaneously has placed additional burdens on the program and the contractor's managers. According to program documentation, these issues place the program at risk of not being able to meet its testing and delivery milestones.

MDA has taken some steps to mitigate the project's schedule risks. According to Aegis Ashore officials; they believe "lessons learned" from the construction of the Romania site can be utilized in Poland to offset some schedule compression. Specifically, to reduce schedule risks, the program plans to add additional personnel and is working with the contractor to prevent the delays from further impacting the project

schedule. Consequently, according to program documentation, the program expects to complete the installation and delivery of Aegis Ashore Poland on schedule in 2018 and meet the EPAA Phase 3 deadline. However, further delays could result in either delaying the planned delivery or not having sufficient time to conduct all planned testing limiting the warfighter's understanding of the system's capabilities and limitations.

Appendix IV: Aegis Ballistic Missile Defense (BMD) Standard Missile-3 (SM-3) Block IB

Figure 13: Aegis Ballistic Missile Defense Standard Missile-3 Block IB 2017 Appendix IV

Key Findings for Fiscal Year 2016

- Aegis BMD SM-3 Block IB delivered for operational use, but technical issues remain.
- MDA delayed a full-rate production decision until it could better test and implement design changes.

Source: Missile Defense Agency (MDA) and GAO Analysis of MDA Data. | GAO-17-381

Program Overview

The Aegis BMD Standard Missile-3 (SM-3) Block IB is a ship-and shore based missile defense system interceptor designed to intercept short- to intermediate-range ballistic missiles during the middle stage of their flight. It is an upgraded version of the earlier, SM-3 Block IA and features an enhanced seeker capability for increased discrimination, an advanced signal processor for engagement coordination, an improved throttleable divert and attitude control system for adjusting its course, and increased range.[1] The SM-3 Block IB interceptor is linked with the Aegis Ballistic Missile Defense (BMD) Weapons System and Aegis Ashore.

In September 2014, the Missile Defense Agency (MDA) began production of an upgraded version called the SM-3 Block IB Threat Upgrade (TU) which is designed to capitalize on improvements in Aegis Weapon System capability advancements. It is primarily comprised of software upgrades with some associated hardware changes to enhance

[1]We did not assess the Aegis BMD SM-3 Block IA because it has been in production since 2005 and is currently operational for regional defense in Europe, as well as other regions.

discrimination capability—the ability of the seeker to distinguish the incoming missile from other objects.

In fiscal year 2016, the Block IB program overcame prior development challenges and successfully intercepted a target in a flight test. We previously reported that the SM-3 Block IB production line was repeatedly disrupted since 2011 due to flight test anomalies. For additional information about the Aegis Weapon Systems, Aegis Ashore and Aegis BMD SM-3 Block IIA see Appendices II, III and V, respectively. Table 9 below highlights key fiscal year 2016 Aegis BMD SM-3 Block IB program facts.

Table 9: Aegis Ballistic Missile Defense (BMD) Standard Missile-3 (SM-3) Block IB Program Facts

Major Assets Delivered Fiscal Year 2016

Delivered 33 Aegis BMD SM-3 IB interceptors in fiscal year 2016 against 47 planned deliveries

Fiscal Year 2016 Flight Test Performance

Test Name	Test Date	Test Result
FTO-02 E2a	October 2015	Success[a] – SM-3 interceptor failed
FTO-02 E1a	December 2015	Success
SM CTV-01	February 2016	System Failure[b]
SM CTV-01a	May 2016	Success (non-intercept)
SM CTV-02	May 2016	Success (non-intercept)

Source: GAO analysis of Missile Defense Agency data | GAO-17-381

[a]The test is characterized as a success because the test achieved its primary objectives.

[b]During the conduct of SM CTV-01, the Aegis BMD SM-3 interceptor failed to launch from the Aegis ship.

Aegis BMD SM-3 Block IB delivered for operational use, but technical issues remain

MDA successfully tested and delivered the Standard Missile-3 Block IB for operational use in fiscal year 2016, but the program still faces several technical issues, some of which have implications for performance or reliability. According to the Department of Operational Test and

Evaluation, these reliability issues could negatively affect the interceptor's operational effectiveness due to the chance of the missile failing in flight. MDA assessed the interceptor's reliability as being within its requirements, but is taking steps to address the risks. These steps include redesigning certain components and working with Raytheon to address quality and production issues that have been discovered during recent reviews.

Addressing reliability concerns discovered during testing introduced delays and additional costs. The SM-3 Block IB program experienced two separate test failures in fiscal year 2016 that required convening a Failure Review Board to identify root causes for the failure and implement corrective actions. As a result of the failures, MDA suspended deliveries of additional interceptors, and as a result MDA missed its target for interceptor delivery. The program has identified the components responsible for the failures and will incorporate fixes during the recertification process.

MDA delayed a full production decision until it could better test and implement design changes.

In part in response to one of our prior recommendations, MDA postponed putting into production a significant design change to the interceptor's third-stage rocket motor until properly tested.[2] MDA further delayed its decision to enter full production, from the 2nd quarter of fiscal year 2016 to the 2nd quarter of fiscal year 2017 while attempting to address issues identified in the most recent test failure. MDA has delayed full production multiple times over the life of the SM-3 Block IB, which was initially scheduled for fourth quarter, fiscal year 2012.

MDA successfully tested the new third-stage rocket motor design with two non-intercept flight tests– Standard Missile Controlled Test Vehicle (SM CTV)-01a and SM CTV-02. The redesign is intended to increase interceptor reliability, and was necessitated by a test failure in October 2013. The program initially planned to execute the tests in February 2016, but delayed the tests after the SM-3 Block IB failed a diagnostic test

[2]GAO, *Missile Defense: Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities,* GAO-15-345 (Washington, D.C.: May 6, 2015).

before the initial attempt. The tests were successfully completed in May 2016 and the redesign was approved for production in July 2016. The first missiles with the redesigned rocket motor are expected for delivery in the second quarter of fiscal year 2017. MDA plans to retrofit existing SM-3 Block IB interceptors during the periodic recertification process. The cost to fix each interceptor is expected to be about $545 thousand per interceptor.

Appendix V: Aegis Ballistic Missile Defense (BMD) Standard Missile-3 (SM-3) Block IIA

Figure 14: Aegis Ballistic Missile Defense Standard Missile-3 Block IIA Appendix V

Key Findings for Fiscal Year 2016

- Aegis Ballistic Missile Defense Standard Missile-3 Block IIA testing revealed technical challenges.
- The program faces several challenges, including persistent cost growth and schedule risks.

Source: Missile Defense Agency (MDA) and GAO Analysis of MDA Data. | GAO-17-381

Program Overview

The Aegis Ballistic Missile Defense (BMD) Standard Missile-3 (SM-3) interceptor has multiple versions in development or production: the SM-3 Blocks IA, IB, and IIA. The SM-3 Block IIA interceptor's design provides increased speed, more sensitive seeker technology, and an advanced kinetic warhead. It is expected to defend against short-, medium-, and intermediate-range ballistic missiles. Additionally, most of the SM-3 Block IIA components will differ from other standard missile versions requiring new technology being developed for the majority of the SM-3 Block IIA components. This interceptor is planned to have increased range compared to earlier SM-3s. For additional information on the SM-3 Block IB interceptor, see Appendix IV.

Initiated in 2006 as a cooperative development program with Japan, the SM-3 Block IIA program was added as a capability to support the European Phased Adaptive Approach (EPAA) Phase 3 to defend against longer range threats. The SM-3 Block IIA interceptor is planned to be fielded with Aegis Weapons System 5.1 by the 2018 time frame and is expected to provide engage on remote capability, in which data from other sensors is used to engage a target, and expand the range available to intercept a ballistic missile. For additional information on the Aegis

Weapon Systems, see Appendix II. Table 10 provides key fiscal year 2016 Aegis BMD SM-3 Block IIA program facts.

Table 10: Aegis Ballistic Missile Defense (BMD) Standard Missile-3 (SM-3) Block IIA Program Facts

Major Assets Delivered Fiscal Year 2016

N/A - Note: The program remains in product development and testing

Fiscal Year 2016 Flight Test Performance

Test Name	Test Date	Test Result
SCD CTV-02	December 2015	Success (non-intercept)

Source: GAO analysis of Missile Defense Agency data | GAO-17-381

Aegis BMD SM-3 Block IIA testing revealed technical challenges

The Aegis BMD SM-3 Block IIA conducted one test in fiscal year 2016, which revealed some technical challenges. Although delayed due to developmental challenges with the guidance system, the SM-3 Block IIA program conducted a non-intercept test named Standard Missile-3 Cooperative Development Controlled Test Vehicle (SCD CTV)-01 in June 2015, as well as the second non-intercept test–SCD CTV-02–in December 2015. Both tests demonstrated key capabilities including the ability to control the interceptor through the final rocket stage, separation of the kinetic warhead, and operation of the warhead after separation. The tests were successful by these measures, but still exposed some technical problems that could affect its schedule and result in further cost overruns. These challenges include design issues with missile guidance systems, which steer the interceptor to the target, and missile communication with sensors.

In order to assess these issues and incorporate lessons learned, the next test, which was also the first intercept test – Standard Missile-3 Block IIA Flight Test Mission (SFTM)-01 – was delayed from the end of fiscal year 2016 to February, 2017.[1] MDA previously stated that any further delay in SFTM-01 could impact the schedule for SFTM-02, and with it, MDA's

[1] MDA completed SFTM-01 February 3, 2017. Program officials stated that the test was a success. However, the test analysis is ongoing.

initial production decision scheduled for the fourth quarter of fiscal year 2017. Program documentation also stated that additional schedule delays could affect future planned testing and increase overall program cost. Despite these risks, MDA does not believe these issues will impact the schedule for EPAA Phase 3.

The program faces several challenges, including persistent cost growth and schedule risks

The development of the SM-3 Block IIA continues to deal with cost growth, in addition to schedule problems and technical issues, all of which threaten the ability to deliver an effective interceptor on time and within budget. The Missile Defense Agency reports that the contractor's estimated cost at program completion increased by around $61 million. While the program has implemented some mitigation measures, according to program documentation, additional growth threatens to result in funding shortfalls.

The program has also experienced a delay in awarding the contract for the materials needed to build interceptor test rounds, which has had further impact on the program schedule. In particular, the procurement delay has required adjustments to Flight Test Mission (FTM) -29, the first flight test designed to fire the interceptor against an intermediate-range target while relying on remote sensor data. While the program is taking steps to mitigate the delay, risk remains that the test will be delayed which could affect the scheduled EPAA Phase 3 declaration date.

Appendix VI: Command, Control, Battle Management, and Communications (C2BMC)

Figure 15: Command, Control, Battle Management, and Communications Appendix VI

Key Findings for Fiscal Year 2016

- C2BMC demonstrated new capabilities but testing had limitations.
- Schedule delays increase sustainment costs performance risks for Spiral 6.4.
- Future spirals are in development, however, developmental challenges could affect planned capabilities.

Source: Missile Defense Agency (MDA) and GAO Analysis of MDA Data. | GAO-17-381

Program Overview

C2BMC is a global system of hardware—workstations, servers, and network equipment—and software that link ad integrated individual missile defense elements of the Ballistic Missile Defense System (BMDS). It allows users to plan operations, see the battle develop, and manage sensors. As the integrator, C2BMC enables the defense of a larger area than the individual BMDS elements operating independently and against more missiles simultaneously, thereby conserving interceptor inventory. C2BMC delivers capabilities via software spirals and hardware upgrades. Currently, C2BMC's fielded spiral is named Spiral 6.4, but the program is working on multiple efforts that are expected to provide additional capabilities. Table 11 provides key fiscal year 2016 C2BMC program facts.

Table 11: Command, Control, Battle Management, and Communications (C2BMC) Program Facts

Major Assets Delivered Fiscal Year 2016

Spiral 6.4 remains in operational use for all geographical areas.

Fiscal Year 2016 Flight Test Performance[a]

Test Name	Test Date	Test Result
FTO-02 E2a	October 2015	Success – SM-3 interceptor failed
FTO-02 E1a	December 2015	Success
GM CTV-02+	January 2016	Success

Source: GAO analysis of Missile Defense Agency data | GAO-17-381

[a]The list represents a portion of the tests C2BMC participates in, but is not comprehensive.

C2BMC demonstrated new capabilities but testing had limitations

During fiscal year 2016, the Missile Defense Agency (MDA) demonstrated C2BMC capabilities in a number of flight and ground tests. These capabilities included threat assessment and evaluation, management of sensor resources, reporting of missile tracks for use by BMDS shooters like Aegis Ballistic Missile Defense (BMD), and engagement monitoring. For example:

- During BMDS level grounds tests, it demonstrated performance of the currently fielded spiral, which received upgrades to support discrimination efforts for Homeland Defense. Specifically, Spiral 6.4-3 provided discrimination tasking of a forward positioned radar for long-range threats, multiple-radar discrimination tasking of a threat, and several fixes related to sequencing and timing of messages.
- During Ground-based Midcourse (GM) Controlled Test Vehicle-02+, MDA collected data on fire control, enhanced tracking, post-intercept assessment, and discrimination for upcoming Spiral 8.2.
- During Flight Test Operational-02 Event 1a, C2BMC demonstrated support to a key European Phased Adaptive Approach Phase 2 capability called Launch on Remote via processing of a BMDS radar's

tracking data, reporting of this track onto DOD's communication network for use by Aegis BMD.

However, MDA's fiscal year 2016 assessment of C2BMC has limitations. For example, although it was assessed during ground tests, C2BMC's control of two AN/TPY-2 radars has not been operationally flight tested. Moreover, according to the Director, Operational Test and Evaluation, C2BMC has not demonstrated real-time engagement direction capabilities, which would significantly increase BMD system-level integration.

Schedule delays increase sustainment costs performance risks for Spiral 6.4

C2BMC continued sustainment for Spiral 6.4, by awarding a new sustainment task order in December 2015, and delivered capability upgrades to this spiral in order to support the assessment and BMD system-level discrimination upgrades for Homeland Defense. While MDA is developing Spiral 8.2-1 to replace Spiral 6.4 in the December 2017 time frame, schedule delays require that Spiral 6.4 remains operational in Europe and in the Middle East until the delivery of Spiral 8.2-3 in December 2018.

The need to sustain Spiral 6.4 until 2018 however, increases performance risk and sustainment cost due to cyber vulnerabilities, as the spiral uses outdated Windows XP. According to program documentation, critical security vulnerabilities are a potential risk while the spiral remains operational. The potential consequences include degraded situational awareness, reduced mission planning capabilities, and target location reporting which would affect the way the warfighter would be able to conduct an engagement. The program continues to monitor this risk to address vulnerabilities and to mitigate new threats as they are discovered.

Future spirals are in development, however, developmental challenges could affect planned capabilities

MDA is developing spirals that are expected to provide additional protections for defending the United States and for EPAA Phase 3—Spiral 8.2-1 and 8.2-3, respectively. However, the spirals are experiencing challenges in development that could affect planned capability deliveries. Specifically:

- Spiral 8.2-1— planned to support Enhanced Homeland Defense capabilities in December 2017.[1] The spiral completed element level development activities and completed early integration testing to address some interoperability concerns with other elements. Nonetheless, C2BMC continues to monitor interoperability issues as a risk. According to program documentation, the probability that interoperability issues could be discovered during BMD system-level ground testing is very high, based on experience from previous tests and the lack of usual risk reduction ground testing, that was removed last year due to fiscal constraints and testing reprioritization. Removal of this test, however, reduced opportunities to find and fix interoperability issues. Should one of the more significant deficiencies be discovered, program documentation indicates that performance of C2BMC and Enhanced Homeland Defense capabilities may be degraded.

[1]Enhanced Homeland Defense is a set of development and fielding activities that add capability for defense of the United States. It includes the fielding of 44 Ground based interceptors, increasing the reliability of the kill vehicle and improving discrimination for the Ground-based Midcourse defense. For further details on the Ground-based Midcourse defense, see appendix VII.

- Spiral 8.2-3 is planned to support EPAA Phase 3 delivery in December 2018.[2] However, the program is currently tracking a risk to an element level C2BMC capability needed for EPAA Phase 3 called Engage on Remote.[3] Specifically, program documentation indicates quality of tracking data provided by C2BMC may be lower than expected and reduce the likelihood of the successful outcome of engagements utilizing Aegis Ballistic Missile Defense in Engage on Remote scenarios.

[2]EPAA Phase 3 is being developed to expand the existing protection of Europe.

[3]Engage on Remote integrates Aegis Ballistic Missile Defense with forward-based radars and C2BMC to allow the warfighter to acquire and intercept an enemy ballistic missile sooner and, consequently, defend a larger area. For further details on Aegis BMD, see appendix II.

Appendix VII: Ground-based Midcourse Defense (GMD)

Figure 16: Ground-based Midcourse Defense Appendix VII

Key Findings for Fiscal Year 2016

- GMD flight testing continued in fiscal year 2016, although it did not conduct all tests scheduled for the year, increasing risk to the fielding plan for interceptors.
- GMD increased its capability by upgrading and fielding 6 of 8 planned Ground-based Interceptors and installing an additional communication location.

Source: Missile Defense Agency (MDA) and GAO Analysis of MDA Data. | GAO-17-381

Program Overview

The GMD program is a ground-based defense system designed to defend the United States against a limited intermediate and intercontinental ballistic missile attack in the middle part of their flight. Key components include a ground-based interceptor consisting of a booster with an exoatmospheric kill vehicle (EKV) on top, as well as a communication system and a fire control capability. The kill vehicle uses on-board sensors and divert capabilities to steer itself into the threat missile to destroy it.

There are two versions of interceptors that are currently fielded, the version with the initial kill vehicle, called Capability Enhancement (CE)-I, and the upgraded version, called CE-II. Both of these interceptor versions are paired with the first generation boost vehicle. The Missile Defense Agency (MDA) is currently developing a new interceptor version called CE-II Block I, consisting of new divert thrusters and an upgraded boost vehicle that addresses obsolescence issues and problems previously discovered during flight testing. In addition, MDA initiated the development of a Redesigned Kill Vehicle that is intended to address concerns about GMD's fleet reliability. According to program officials, the Redesigned Kill Vehicles are not expected to begin fielding until 2022 and are not covered in this appendix because it has not been baselined.

In March 2013, the Secretary of Defense announced plans to increase the number of deployed GMD interceptors called Ground-based interceptors (GBI) from 30 to 44 by the end of 2017 to add protection to the homeland and to stay ahead of long-range ballistic missile threats. Table 12 highlights key fiscal year 2016 GMD program facts.

Table 12: Ground-based Midcourse Defense (GMD) Program Facts

Major Assets DeliveredFiscal Year 2016

- Delivered six upgraded ground-based Interceptors against the planned eight
- In-flight Interceptor Communications System Data Terminal at Fort Drum, New York

Fiscal Year 2016 Flight Test Performance

Test Name	Test Date	Test Result
GM CTV-02+	January 2016	Success, but failure mode observed[a]
FTG-15	4th Quarter Fiscal year 2016	Delayed until 3rd Quarter Fiscal Year 2017

Source: GAO analysis of Missile Defense Agency data | GAO-17-381

[a]GM CTV-02+ was designed to demonstrate ADTs for future GMD interceptors. A kill vehicle component failed which prevented one of the thrusters from working for a segment of the test.

GMD flight testing continued in fiscal year 2016, although it did not conduct all tests scheduled for the year, increasing risk to the fielding plan for interceptors.

GMD continued to demonstrate additional capability when it conducted a non-intercept flight test named GMD Controlled Flight Test-02+ (GM CTV-02+), however developmental challenges caused MDA to delay the second planned test until at least the third quarter of fiscal year 2017. On January 28, 2016, MDA conducted a non-intercept flight test for the GMD program. The test was designed to demonstrate discrimination functionality and a new alternate divert thruster (ADT) system. As we previously reported, MDA initiated the development of the ADT—a component that steers the kill vehicle in flight—to address the systemic

problem of in-flight vibration.[1] According to DOT&E, the ADTs turned on and off as commanded and performed nominally, but the EKV experienced an anomaly—most likely damage caused by an foreign-object in a subcomponent not considered part of the ADT system. In 2016, DOT&E reported that GMD demonstrates a limited defense capability in part, because of the system's low reliability and the continual discovery of new failure modes during testing. In addition, although the test was able to capture significant data for increasing GMD's discrimination capability, according to officials from the Director, Developmental Test and Evaluation, the threat scene lacked a realistic representation.

MDA delayed the planned intercept test—Flight Test GMD (FTG)-15—from the fourth quarter of fiscal year 2016 until at least the third quarter of fiscal year 2017. FTG-15 is designed to be the first GMD test against an Intercontinental Ballistic Missile range target using upgraded avionics in the booster. We have previously reported on the need for GMD to conduct this test so the warfighter can have a better understanding on the interceptor's capabilities and limitations.[2] According to program documentation, FTG-15 was delayed, in part, due to developmental challenges with the interceptor.

Delays in conducting FTG-15 increase the risk to completing the fielding of 44 GBIs by the end of December 2017. According to program documentation, the program recognizes that to complete the deadline, concurrency is warranted, but is taking mitigation steps to reduce the risks of a compressed schedule. As we have previously reported, GMD is relying on high-risk acquisition practices, including concurrent development and fielding to achieve its goal of fielding 44 interceptors by the end of 2017.[3] Delaying FTG-15, increases this risk associated with fielding interceptors within its established time frame because it will reduce the time between the conduct of the test and the subsequent manufacturing and fielding of the GBIs necessary to complete the requirement.

[1]GAO, *Missile Defense: Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities,* GAO-15-345 (Washington, D.C.: May 6, 2015).

[2]GAO-15-345.

[3]*Missile Defense: Ballistic Missile Defense System Testing Delays Affect Delivery of Capabilities,* GAO-16-339R (Washington, D.C.: Apr. 28, 2016).

GMD increased its capability by refurbishing and fielding 6 of 8 planned Ground-based Interceptors and installing an additional communication location

GMD continued to make progress in completing its planned fielding of 44 GBIs by the end of calendar year 2017 by refurbishing, delivering, and fielding six of the planned eight GBIs. Upgrades of CE-II interceptors is ongoing the GMD program experienced developmental setbacks that resulted in necessary changes to the CE-II interceptor's guidance system.

In addition to fielding interceptors, GMD increased its capability by completing the installation of an additional communication location in July 2016 called the In-Flight Interceptor Communications System—designed to serve as the communications link to interceptors. The In-Flight Interceptor Communications System serves an important function as it provides the GMD system with one last opportunity to send data about the threat location as well as the inflight status of the GBI during an engagement. According to the Director, MDA, the site at Fort Drum, New York will enable communication with GBIs over longer distances and improve defenses for the Eastern United States.

Appendix VIII: Targets and Countermeasures

Figure 17: Targets and Countermeasures Appendix VIII

Key Findings for Fiscal Year 2016

- Targets overcame prior failure to complete two operational tests in fiscal year 2016.
- Continued use of targets without risk reduction flight tests increase risk of cost growth and schedule delays.

Source: Missile Defense Agency (MDA) and GAO Analysis of MDA Data. | GAO-17-381

Program Overview:

The Ballistic Missile Defense System (BMDS) Targets and Countermeasures program provides centrally managed targets for a cost effective, integrated system level approach to BMDS testing. The Missile Defense Agency's (MDA) Targets and Countermeasures (hereafter referred to as Targets) designs, develops, and procures missiles to serve as targets during the testing of independent or integrated ballistic missile defense elements. As such, targets are test assets and are not operationally fielded. A typical target consists of a launch vehicle with one or more boosters, a control module that steers the vehicle after the booster stage separates, a payload module that can deploy countermeasures, and a surrogate re-entry vehicle. The Targets program provides multiple short-, medium-, intermediate-, and intercontinental range targets for testing the BMDS elements. However, the numbers of each vary based on element requirements and testing schedules.

The Targets program acquires many types of targets covering the full spectrum of threat missile capabilities and ranges. Based on engineering assessments of threat intelligence data, the BMDS Targets Program develops, builds, and supports the launch of Short Range Ballistic Missile (Less than 1000 Kilometer range) targets, Medium Range Ballistic Missile (1000-3000 Kilometer Range) targets, Intermediate Range Ballistic Missile (3000-5500 Kilometer Range) targets, Intercontinental Ballistic Missile (greater than 5500 Kilometer range) targets, and Multiclass

Components to test, verify, and validate the performance of the BMDS against threats. While some targets have been used by MDA's test program for years, others have been added recently or are now being developed to more closely represent current and future threats. The quality and availability of these targets are instrumental to the execution of MDA's flight test schedule. Table 13 provides key fiscal year 2016 Targets and Countermeasure program facts.

Table 13: Targets and Countermeasure Program Facts

Major Assets Delivered Fiscal Year 2016

Targets provided 5 targets to be used in flight testing

Fiscal Year 2016 Flight Test Performance

Test Name	Test Date	Test Result
FTO-02 Event 1a	December 2015	Target performed nominally
FTO-02 Event 2a	November 2015	Target performed nominally
FTO-02 Event 2	October 2015	Target failed
FTX-21	May 2016	Target performed nominally
GM CTV-02+	January 2016	Target performed nominally

Source: GAO analysis of Department of Defense data | GAO-17-381

Targets program overcame prior failure to complete two operational tests in fiscal year 2016

In fiscal year 2016, MDA was successful in conducting two operational flight tests, but was unable to complete its planned flight test plan due, in part, to target failures in two prior tests for the targets program. The failures in conducting the tests resulted in MDA readjusting its test plan to reconduct the two flight tests. As we previously reported, targets' reliability and availability problems have significantly affected BMDS development and testing schedules since 2006, and issues have grown

even more problematic in recent years.[1] In addition, these problems have caused delays in MDA's test program resulting in less testing than planned and the delivery of assets before testing has demonstrated the assets capabilities and limitations.

According to the Director, Operational Test and Evaluation, the operational flight tests—Flight Test Operational (FTO)-02 Events 1 and 2—were designed as events necessary to provide critical data for the assessment of the European Phased Adaptive Approach (EPAA) Phase 2.[2] Specifically, the two tests were to demonstrate Aegis Ashore's capability to defend Europe against medium range threats and the ability to integrate EPAA capabilities.

- FTO-02 Event 1—attempted June 2015—a new intermediate-range target malfunctioned due to a safety switch that did not indicate, as designed, that it had safely cleared the aircraft from which it is launched. The malfunction prevented the target from executing sequential steps and failed to fly as intended and therefore the test had to be repeated.[3] MDA reallocated another intermediate range target and successfully conducted the test in December, 2015. Consequently, costs for this first event of the BMDS operational test doubled, increasing from about $96 million to $192 million.
- During FTO-02 Event 2—attempted October 2015—the short-range air launched target's parachute failed to open causing the agency to replan the test. It was successfully conducted as FTO-02 Event 2a October 31, 2015.

While MDA was able to conduct the two tests in fiscal year 2016, the need to repeat the flight tests compressed the time available to analyze

[1]See *Defense Acquisitions: Production and Fielding of Missile Defense Components Continue with Less Testing and Validation Than Planned*, GAO-09-338 (Washington, D.C.: March 13, 2009); *Missile Defense: Opportunity Exists to Strengthen Acquisitions by Reducing Concurrency,* GAO-12-486 (Washington, D.C.: Apr. 20, 2012); and *Missile Defense: Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities,* GAO-15-345 (Washington, D.C.: May 6, 2015).

[2] The European Phased Adaptive Approach (EPAA) provides defense of regional allies and United State forces in Europe. Phase 2 builds on the previously delivered Phase 1. For further details about EPAA, see GAO, *Regional Missile Defense: DOD's 2014 Report Generally Addressed Required Reporting Elements, but Excluded Additional Key Details*, GAO-15-32 (Washington, D.C. December, 2014).

[3] *Missile Defense: Ballistic Missile Defense System Testing Delays Affect Delivery of Capabilities,* GAO-16-339R (Washington, D.C.: Apr. 28, 2016).

any test results and precluded the validation of key models used in the ground tests before the European Phased Adaptive Approach Phase 2 delivery in December 2015.[4] Specifically, as originally planned, MDA and relevant test officials had up to approximately 6 months to analyze test results, whereas the retests only allowed between 9 and 48 days. In addition, testing prioritization caused MDA to reschedule a test to support the Terminal High Altitude Area Defense (THAAD) test—FTT-18—to fiscal year 2017. FTT-18 is intended to demonstrate THAAD's capability against intermediate range threats. This test is necessary because THAAD has already deployed a battery to Guam to defend against this range. Consequently, it will be four years that the asset will be deployed before its capability has been demonstrated. For additional information on THAAD, see appendix IX.

Continued use of targets without risk reduction flight tests increase risk of cost growth and schedule delays

MDA has experienced test failures and delays due to problems with target performance and availability. Specifically, as we previously reported, the use of new, untested targets introduces higher risk for failure that can mean costly and time consuming retests.[5] Accordingly, we recommended that MDA add a non-intercept flight test for each new target type to verify its performance and reduce risk for future tests. DOD partially concurred with our recommendation, stating that the agency will weigh risk against the cost, schedule and programmatic impacts. However, as noted above, the failure in FT0-02 Event 1 cost an additional $223 million to reconduct and resulted in the delay of demonstrating a capability of a fielded asset.

Due to the addition of new tests and retests in fiscal year 2016, MDA had to deconflict its test schedule by delaying multiple, in some instances critical, tests. For example, GMD's next intercept flight test—Flight Test GMD (FTG)-15 was delayed from fiscal year 2016 until the first quarter of fiscal year 2017 (subsequently delayed until at least the third quarter of fiscal year 2017 due to booster issues). FTG-15 carries an increased risk

[4] GAO-15-345.

[5] GAO, Missile Defense: *Opportunity to Refocus on Strengthening Acquisition Management*, GAO-13-432 (Washington, D.C.: April 26, 2013).

as it will be the first flight of a new range target. Specifically, MDA plans to use a new intercontinental-range target during the test that is necessary to demonstrate GMD's capability against this range and also a new booster design before completing its mandated goal of fielding 44 interceptors by the end of 2017. Any further delays in conducting the test, will reduce the time necessary to assess the flight test data, incorporate any "lessons learned" into the design— if necessary— and complete the requirement to field 44 interceptors by the end of calendar year 2017. For further details on the GMD program, see appendix VII.

Appendix IX: Terminal High Altitude Area Defense (THAAD)

Figure 18: Terminal High Altitude Area Defense Appendix IX

Key Findings for Fiscal Year 2016

- THAAD successfully participated in a key Ballistic Missile Defense test, but did not complete its planned schedule.
- Parts quality issues resulted in the production of the interceptor being temporarily halted.

Source: Missile Defense Agency (MDA) and GAO Analysis of MDA Data. | GAO-17-381

Program Overview:

THAAD is a rapidly-deployable ground-based system able to defend against short- and medium-range ballistic missile attacks during the middle and end stages of a missile's flight. THAAD is organized as a battery that consists of interceptors, launchers, a radar, a fire control and communications system, and other support equipment. The first two batteries have been conditionally accepted by the Army for operational use. In December 2014, THAAD received urgent materiel release approval from the Commanding General of the United States Army Aviation and Missile Command to enable an earlier delivery of equipment for the next two batteries for operational use to meet the Army's request to support urgent warfighter needs.[1] The Missile Defense Agency (MDA) plans to continue THAAD production through fiscal year 2025, for a total of 7 batteries, 428 interceptors, and 7 radars.

[1]The materiel release process ensures that a weapon system is safe, suitable, and supportable prior to placing it in the hands of the warfighter. Generally, all weapon systems used by the Army must go through the materiel release process. An urgent materiel release provides a limited certification of a weapon system's safety, suitability, and supportability and bypasses the standard materiel release process to meet pressing operational needs or demands. THAAD must complete a full materiel release process for this weapon system in the future. Army Regulation 700-142.

MDA has two THAAD acquisition efforts—THAAD 1.0 and THAAD 2.0. THAAD 1.0 is for the production of the batteries, interceptors, and supporting hardware and provides the warfighter with initial integrated defense against short- and medium-range threats in one region. THAAD 2.0 is primarily software enhancements that expand THAAD's ability to defend against threats in multiple regions and at different ranges, and adds debris mitigation and other upgrades.

THAAD currently has two hardware configurations—one for the first two batteries and another to address obsolescence issues for the remaining five batteries. However, the program plans to equip the first two batteries with the upgraded hardware by fiscal year 2018. Table 14 provides key fiscal year 2016 THAAD program facts.

Table 14: Terminal High Altitude Area Defense (THAAD) Program Facts

Major Assets Delivered Fiscal Year 2016

- THAAD delivered 21 of the planned 48 THAAD interceptors
- Battery 6 equipment was delivered in the fourth quarter of fiscal year 2016 as planned

Fiscal Year 2016 Flight Test Performance

Test Name	Test Date	Test Result
FTO-02 Event 2a	October 2015	Success

Source: GAO analysis of Missile Defense Agency data | GAO-17-381

THAAD successfully participated in a key Ballistic Missile Defense test, but did not complete its planned schedule

MDA demonstrated increased capability for THAAD in fiscal year 2016, however delays in its flight test schedule resulted in a key capability remaining unproven. In Flight Test Operational-02 Event 2a, THAAD successfully demonstrated its effectiveness against theater and regional threats in October 2015. For the first time, THAAD interceptors that represent the fielded configuration intercepted one complex short range and one medium range threat-representative target. In addition to testing

against new threat characteristics and addressing outstanding conditions needed to support the Army's full acceptance of the its equipment, THAAD demonstrated advanced software in its radar. However, recent obsolescence redesigns of hardware and software, which were fully integrated for the first time in this test, caused unintended problems.

Despite demonstrating increased developmental capability, a delay to a key flight test— FTT-18—results in the system's capability against an intermediate-range threat remaining unproven. In 2013, MDA delivered THAAD assets to Guam, at the Army's request, to defend against intermediate-range threats although this capability had not been demonstrated in a flight test. As we previously reported, MDA did expect to conduct a flight test against this threat in fiscal year 2015, however, due to testing prioritization, FTT-18 will not be attempted until at least the third quarter of fiscal year 2017. As such, THAAD program officials currently have limited data necessary to provide information on how the system will perform against an intermediate-range threat. However, program officials expect THAAD to perform successfully based on modeling and simulations and analysis from a previous flight test that used a medium-range target with a velocity close to that of an intermediate-range target.[2] If THAAD does not perform as expected during FTT-18, the program may have to retrofit its currently deployed assets at an additional cost.

Parts quality issues resulted in the production of the interceptor being temporarily halted

In fiscal year 2016, MDA delivered 21 of its planned 48 THAAD interceptors due to parts quality issues that resulted in production of the interceptor being temporarily halted. Specifically, during component testing, Lockheed Martin—THAAD's contractor—discovered an issue with a connector in the interceptor, as it failed multiple testing iterations. Upon investigation, the contractor learned that one of its sub-vendors changed

[2] A model is a representation of an actual system via computer simulations that can predict how the system might perform or survive under various conditions or in a range of hostile environments. A simulation is a method for implementing a model, such as experiments for the purpose of understanding the system's behavior under selected conditions. Models and simulations are critical to understanding performance beyond what demonstrated in flight testing, as testing against realistic ballistic missile raids is impossible during flight test due to cost and safety constraints.

the manufacturing process on the connector without informing Lockheed Martin and, as a result, production was temporarily halted. According to THAAD program officials, there has been a renewed emphasis on parts quality supported by a policy memo to emphasize parts quality assurance and the verification of implementation of various requirements for doing so, including onsite verification assessments at subcontractor facilities.[3]

[3]Missile Defense Agency Policy Memo Number 86, "Parts, Materials, and Processes Requirements Verification," (April 7, 2016).

Appendix X: GAO Contact and Staff Acknowledgments

GAO Contact:

Cristina Chaplain (202) 512-4841 or chaplainc@gao.gov

Staff Acknowledgments:

In addition to the contact named above, LaTonya Miller, Assistant Director; Matthew Ambrose; Jeff Cherwonik; Jennifer Echard; Stephanie Gustafson; Helena Johnson; Joe Kirschbaum; Jason T. Lee; Katherine Lenane; Wiktor Niewiadomski; Karen Richey; Steven Stern; Brian Tittle; Hai V. Tran; Alyssa Weir; and Robin Wilson.

Appendix XI: Accessible Data

Data Tables

Data Table for Highlights Figure: Missile Defense Agency's Progress for Fiscal Year 2016 Against Planned Goals

	Delivered/Conducted
Tests Conducted	75%
Assets Delivered	59%
Capabilities Delivered	100%

Data Table for Figure 4: Missile Defense Agency's (MDA) Flight Test Execution for the Ballistic Missile Defense System for Fiscal Years 2010-2016

Fiscal year	Conducted as planned	Backlogged test (delayed from prior fiscal year)	New test (added to the test schedule)	Delayed or removed test	Total tests for fiscal year
2010	5	3	0	3	11
2011	4	0	2	6	12
2012	1	2	1	10	14
2013	2	7	2	5	16
2014	0	5	0	12	17
2015	2	3	4	12	21
2016	0	4	6	8	18

Agency Comment Letter

Text of Appendix I: Comments from the Department of Defense

Page 1

Ms. Cristina Chaplain

Director, Acquisition and Sourcing Management Government Accountability Office

441 G Street, NW Washington , DC 20548

Dear Ms. Chaplain:

Thank you for the opportunity to review the Government Accountability Office (GAO) Draft Report, GA0- 17-381, "MISSILE DEFENSE: Some Progress Delivering Capabilities, but Challenges with Testing Transparency and Requirements Development Need to be Addressed" dated March 15, 2017 (GAO Code 100857). We reviewed the contents of the report to include the recommendations. In support of the GAO's mission, we have engaged in the review of the statement of facts and the exit conference with the GAO team to ensure the facts are included in the draft report . This year, we provided nearly 100,000 pages of official documentation and hosted over 20 meetings as well as conference calls to support your analysis. This transmittal letter summarizes our review.

DoD agrees with GAO on the need to increase traceability and insight into Missile Defense Agency 's (MDA's) test program ; specifically the need for MDA to include a detailed crosswalk of changes to each test in the Integrated Master Test Plan (IMTP). MDA is in the process of improving test traceability and is on track beginning with IMTP v 19.1 to incorporate this recommendation .

DoD non-concurs with GAO's recommendation to better align MDA 's test scheduling policy to include the use of a schedule Work Breakdown Structure (WBS) and also has concerns with the recommendation for MDA to better rectify testing deficiencies, and cost policy for cost estimating, including the use of common test WBS and the recommendation to document traceability of source data, and codifying its

processes and associated information for the software application Test Resource Mission Planning-Tool (TRMP-T):

- The increase in resources and costs to track at the requested detailed level are cost prohibitive and would at best provide only marginal gain in comparison to the implementation of the recommended crosswalk of changes to each test in the IMTP.
- MDA uses an alternative process to determine required test resources (i.e., executive reviews, recurring mission planning meetings , etc.). Higher-level schedule-driven resource needs are synchronized with the development of the IMTP.
- MDA recognizes a need for a cost model for automated integration of test cost estimates and is using the Integrated Financial Cost Model (IFCM) model to create an agency wide IMPT cost model to support development of IMTP v20 .1.We do not agree with the recommendation requesting the use of the test planning tool, TRMP-T, as a cost model.

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TRMP-T was developed to support test planning and requirements collecting aggregate cost.

DoD also non-concurs with the recommendation to breakout funding requests by test in the BMDS Accountability Report (BAR) and other budget documentation. Title 10 USC 225 directs that MDA submit the BAR yearly to report on component program baselines across 6 areas (Resource, Schedule, Technical, Test, Contract, and Operational Capacity) and specifically directs in the language to track costs versus funding requests for resource reporting. Since tests cross multiple programs, the BAR is not the appropriate document to report test costs.

DoD non-concurs with the recommendation regarding the warfighter capabilities process. This recommendation is based on conclusions drawn from information that does not accurately represent the capability requirements process that exists between US Strategic Command and MDA. MDA's responses in the technical comments submitted to GAO by our Primary Action Officer provide information that accurately describes that process.

DoD also non-concurs with recommendations for the Director, Cost Analysis and Performance Evaluation (CAPE) to review and concur on

MDA's RKV Acquisition Strategy, and also for the Director, CAPE to approve MDA acquisition strategies for all new major efforts. The CAPE is responsible for providing unbiased analysis on resource allocation and cost estimation problems to the Secretary of Defense along with reviewing, analyzing, and evaluating programs execution of approved acquisition strategies and policies and ensuring that information on programs is presented accurately and completely. While CAPE's input may influence production decisions or production related decisions for missile defense related assets, in accordance with Deputy Secretary of Defense approved Department of Defense Directive (DoDD) 5134.09, the Director, MDA is the Acquisition Executive responsible for Ballistic Missile Defense System (BMDS) development, and acquisition strategies. As such, the MDA Director obtains USD (AT&L) approval for production-related decisions.

Detailed comments on the draft GAO report recommendations are enclosed. We appreciate the opportunity for close collaboration with your staff. My point of contact for this effort is Mr. Robert Thomas, e-mail: robert.l.thomas516.civ@mail.mil, and phone number 703- 571-1780.

Dyke Weatherington

Performing the Duties of the

Assistant Secretary of Defense (Acquisition)

Enclosures: As stated

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GAO DRAFT REPORT RELEASED MARCH 15, 2017 GA0-17-381 (GAO CODE 100857)

"MISSILE DEFENSE: SOME PROGRESS DELIVERING CAPABILITIES, BUT CHALLENGES WITH TESTING TRANSPARENCY AND REQUIREMENTS DEVELOPMENT NEED TO BE ADDRESSED"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATION

The GAO recommends that the Secretary of Defense take the following four actions to strengthen MDA's acquisition efforts and strengthen oversight.

RECOMMENDATION 1: To increase traceability and insight into MDA's test program, require MDA to:

a. Include a detailed crosswalk of changes to each test, such as names, planned execution dates, test types, targets, and other modifications, in each iteration of its Integrated Master Test Plan.

b. Address deficiencies in its test scheduling policy by better aligning it with best practices for scheduling, including the use of a schedule WBS that clearly traces each activity to the cost WBS, properly assigning resources to schedules, and clarifying guidance on when and how to conduct schedule risk analysis;

c. Rectify deficiencies in its cost policy by better aligning it with best practices for cost estimating, including requiring the use of the common test WBS, documenting the traceability of source data, and codifying its processes and associated information for it software application (TRMP-T) used for creating the test-level cost estimates in policy; and

d. Breakout funding requests by test in the BAR and other budget documentation submitted during the annual budget submission.

DoD RESPONSE: DoD concurs with recommendation 1.a. DoD does not concur with recommendations 1.b., 1.c., and 1.d.

For recommendation I .a.,

MDA is in the process of improving test traceability and is on track beginning with IMTP version 19.1. MDA will implement improvements in reporting test program changes to Congress, including providing a detailed crosswalk of changes to individual tests compared to the previous IMTP version submitted to Congress.

For Recommendation I .b.,

MDA does not use common schedule WBS or resource loaded Government schedules for programs, elements, or individual tests. The increase in resources and costs to track at the requested detailed level would at best provide only marginal gain in comparison to the implementation of the recommended crosswalk of changes to each test in the

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IMTP. The MDA uses a carefully tailored process to determine required test resources (i.e. executive reviews, recurring mission planning meetings). Higher-level schedule-driven resource needs are synchronized during development of the IMTP. DoD has determined that this approach is adequate to effectively assign and track resources assigned to testing.

MDA is working to improve individual flight and ground test schedules to better meet MDA scheduling policy, which is fundamentally based on the GAO scheduling best practices as well as revise its scheduling policy documentation to address how and when to conduct schedule risk analysis.

For recommendation 1.c.,

the MDA uses established best practices in developing test cost estimates. MDA has vetted its procedures and documentation with the GAO. DoD does not agree with the recommendation to use the test planning tool, TRMP-T, as a cost model. TRMP- T was developed to support test planning and requirements by collecting aggregate cost. MDA recognizes a need for a cost model for automated integration of test cost estimates and is using the Integrated Financial Cost Model (IFCM) model to create an agency wide IMPT cost model to support development of IMTP v20.1.

For recommendation 1.d.,

the DoD non-concurs with the recommendation to breakout funding requests by test in the BDMS Accountability Report (BAR) and other budget documentation. Title 10, United States Code section 225 directs MDA to submit the BAR yearly to include component program baselines of schedule, technical, cost, and test, and specifically directs in the language to track costs versus funding requests for resource reporting. Regarding other budget documentation, testing by nature is a dynamic process with multiple test events planned across multiple years; thus, an 18-24 month process to develop an annual budget makes this an unrealistic recommendation to submit budget documentation by test event.

The MDA provides the data requested in accordance with National Defense Authorization Act (NDAA) for Fiscal Year 2017, Public Law 114-328 § 1695, which requires the Director, MDA to submit a semiannual notification on missile defense tests and costs. This notification includes

"test costs ...funds expended on such attempted test," and is the appropriate documentation to increase traceability and insight into MDA's test program. To address the GAO's recommendation, this data can be provided to the GAO concurrently with the Congressional reporting requirement.

RECOMMENDATION 2: To improve MDA's requirement-setting process and ensure it includes an appropriate balance between MDA and warfighter priorities, require MDA to develop a plan to transition requirements analysis currently performed with in MDA's

Achievable Capabilities List to the Joint Functional Component Command for Integrated Missile Defense, and, in the interim, require MDA to obtain their concurrence of the Achievable Capabilities List prior to its release.

DoD RESPONSE: DoD non-concurs.

This recommendation appears to be based on conclusions drawn from information that does not adequately or sufficiently represent the capability requirements process that exists between U.S. Strategic Command and the MDA. MDA assesses

U.S. Strategic Command's Integrated Air and Missile Defense Prioritized Capabilities List

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(PCL) and, considering timeframe, realistic technology, and resource availability, documents its analysis in an Achievable Capabilities List (ACL). This assessment is a systems engineering function within the MDA acquisition process. Not only does the Joint Functional Component Command for Integrated Missile Defense (JFCC-IMD) not have the skill sets, engineering simulations, and models to perform this type of requirements analysis, it would be inappropriate for JFCC-IMD to perform this inherently acquisition function as suggested by this recommendation. The MDA has provided information that correctly and appropriately describes the capability-based requirements process, warfighter participation in the systems engineering of materiel solutions, and the validation and governance processes that are used extensively to provide missile defense capabilities to the warfighter.

U.S. Strategic Command (STRATCOM) leads the generation, validation, and approval of warfighter ballistic missile defense capability requirements. The MDA interacts with U.S. STRATCOM as well as the other Combatant Commands, JFCC-IMD, Joint Staff, the test community to include the Director Operational Test and Evaluation (DOT&E), and the Office of the Secretary of Defense (OSD) staff during the requirements generation, engineering review, assessment and test planning, test execution and results briefings, and deployment decision meetings. Representatives from these organizations attend many of the working-level and executive decision meetings, resulting in ample verbal and written input from the Warfighter.

RECOMMENDATION 3:

To ensure that the RKV acquisition strategy continues to remain viable, promotes effective competition, and addresses concerns raised by DOD components, require the Director, CAPE to perform a comprehensive review of the RKV acquisition strategy and provide any recommendations to the Secretary of Defense that the Director deems necessary and appropriate to obtain CAPE's concurrence for the RKV program's acquisition strategy. Any decision to award a full-rate production contract should be delayed until after MDA has received approval from the USD(AT&L) to proceed to full-rate production.

DoD RESPONSE: DoD non-concurs.

The Joint Staff, the OSD staff, and CAPE conducted a comprehensive review of the RKV acquisition strategy before the USD(AT&L) approved it on October 8, 2015. In accordance with DoDD 5134.09, USD(AT&L) is the approval authority for all MDA production decisions, including RKV. Title 10, United States Code section 139c, provides that the Director of Cost Assessment and Program Evaluation (CAPE) is responsible for I) ensuring the Department's cost estimation and cost analysis processes provide accurate information and realistic estimates of cost for the major acquisition programs, and 2) for reviewing, analyzing, and evaluating program execution of approved acquisition strategies and policies, and ensuring that information on programs is presented accurately and completely.

Thus, CAPE provides unbiased analysis on resource allocation and cost estimation problems to the Secretary of Defense, however, CAPE's concurrence is not required for acceptance and approval of an acquisition strategy. Further, Title 10, United States Code section 243 l a, which

establishes the requirements for acquisition strategies, does not require CAPE approval of acquisition strategies. While CAPE's input may influence production decisions or production related decisions for missile defense related assets, in accordance with Deputy Secretary of Defense DoDD 5134.09, the Director, MDA is the Acquisition Executive and is responsible for BMDS development, and acquisition strategies. This recommendation would require a change in

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the CAPE's mission, statutorily defined responsibilities, and possibly require a potential change to processes for all acquisition programs across the department.

RECOMMENDATION 4:

To ensure that future acquisition strategies MDA develops for its new efforts reflect an appropriate balance between timeliness, affordability, reliability, and effectiveness and achieve department-wide buy-in, the Secretary of Defense should require MDA to produce acquisition strategies for all its major new efforts that are subject to review and approval by the Director, CAPE and the USD(AT&L).

DoD RESPONSE: DoD non-concurs.

While CAPE's input may influence production decisions or production related decisions for missile defense related assets, in accordance with Deputy Secretary of Defense DoDD 5134.09, the Director, MDA is the Acquisition Executive and is responsible for BMDS development, and acquisition strategies. As such, the MDA Director must only obtain USD (AT&L) approval for production-related decisions. Title 10, United

States Code section 139c, provides that the Director of Cost Assessment and Program Evaluation (CAPE) is responsible for ensuring the Department's cost estimation and cost analysis processes provide accurate information and realistic estimates of cost for the major acquisition programs along with reviewing, analyzing, and evaluating programs execution of approved acquisition strategies and policies and ensuring that information on programs is presented accurately and completely. This recommendation would require a change in the CAPE's mission, statutorily defined responsibilities, and department processes for all acquisition programs across the department.

Related GAO Products

Report Number	Report Date	Report Title
GAO-16-339R	Apr, 2016	*Missile Defense: Ballistic Missile Defense System Testing Delays Affect Delivery of Capabilities*
GAO-15-345	Mar. 2015	*Missile Defense: Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities*
GAO-14-351	Apr. 2014	*Missile Defense: Mixed Progress in Achieving Acquisition Goals and Improving Accountability*
GAO-13-432	Apr. 2013	*Missile Defense: Opportunity to Refocus on Strengthening Acquisition Management*
GAO-12-486	Apr. 2012	*Missile Defense: Opportunity Exists to Strengthen Acquisitions by Reducing Concurrency*
GAO-11-372	Mar. 2011	*Missile Defense: Actions Need to Improve Transparency and Accountability*
GAO-10-311	Feb. 2010	*Defense Acquisitions: Missile Defense Transition Provides Opportunity to Strengthen Acquisition Approach*
GAO-09-338	Mar. 2009	*Defense Acquisitions: Production and Fielding of Missile Defense Components Continue with Less Testing and Validation Than Planned*
GAO-08-448	Mar. 2008	*Defense Acquisitions: Progress Made in Fielding Missile Defense, but Program is Short of Meeting Goals*
GAO-07-387	Mar. 2007	*Defense Acquisitions: Missile Defense Acquisitions Strategy Generates Results but Delivers Less at a Higher Cost*
GAO-06-327	Mar. 2006	*Defense Acquisitions: Missile Defense Agency Fields Initial Capability but Falls Short of Original Goals*
GAO-05-243	Mar. 2005	*Defense Acquisitions: Status of Ballistic Missile Defense Program in 2004*
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