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Report to Congressional Committees

March 2017

DEFENSE ACQUISITIONS

Assessments of Selected Weapon Programs

Accessible Version

GAO-17-333SP

GAO Highlights

Highlights of GAO-17-333SP, a report to congressional committees

March 2017

DEFENSE ACQUISITIONS

Assessments of Selected Weapon Programs

Why GAO Did This Study

This is GAO's annual assessment of DOD's major weapon system acquisitions, an area on GAO's high-risk list. DOD and Congress have taken steps to improve the acquisition of weapon systems. Still some programs continue to experience cost and schedule overruns. GAO continues to emphasize the need for DOD and Congress to hold programs accountable by ensuring that they attain the required knowledge at key decision points before committing resources to development. Given continuing budgetary pressures, DOD cannot afford to miss opportunities to address program inefficiencies.

The joint explanatory statement to the DOD Appropriations Act, 2009 includes a provision for GAO to annually review DOD's portfolio of weapon systems. This report includes observations on (1) the cost and schedule performance of DOD's 2016 portfolio of 78 major defense acquisition programs, (2) program implementation of key acquisition reform initiatives, and (3) the knowledge attained at key decision points for 54 weapon programs in development or early production.

GAO analyzed cost, schedule, and quantity data from DOD's Selected Acquisition Reports from 2010, 2014, and 2015. GAO also collected program office data through two questionnaires on technology, design, and manufacturing knowledge; the use of knowledge-based acquisition practices; and the implementation of acquisition reforms and initiatives.

In commenting on a draft of this report, DOD agreed with GAO's findings and stated that the results validate its focus on continuous program improvements.

View GAO-17-333SP. For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov

What GAO Found

Since GAO's 2016 assessment, the number of programs in the Department of Defense's (DOD) portfolio of major defense acquisitions decreased from 79 to 78, while DOD's planned investment over the life of these programs increased by $9.4 billion to $1.46 trillion. GAO observed mixed performance in the portfolio this year. For example, although the current portfolio has incurred $484 billion in total cost growth, $476 billion of this occurred 5 or more years ago, indicating recent performance has improved. Yet, 60 percent of the total cost growth occurred after programs entered production, when costs should be more stable. However, the portfolio increased its buying power by $10.7 billion—meaning DOD is able to buy more goods or services for the same level of funding. This gain resulted from some programs finding procurement efficiencies that more than offset inefficiencies in other programs. The 19 newest programs decreased their costs by a combined $3.4 billion over the past year.

Implementation of key reform initiatives GAO analyzed for the 45 current and 9 future programs it assessed this year was similar or slightly less as compared to its 2016 assessment. These initiatives address program and portfolio affordability, cost growth controls, and competition use. For example, 42 programs this year reported conducting "should-cost" analyses, which are designed to reduce programs' costs by identifying and eliminating inefficiencies. Programs can take a variety of actions, such as reducing overhead, to do so. Programs implementing "should-cost" analyses reported realizing $23.6 billion in savings, although they could not identify to GAO exactly where $11.0 billion of these savings were transferred within DOD. Also, a similar number of programs reported establishing affordability constraints, which programs use to set priorities and inform what they can and cannot afford. GAO found that current programs with established affordability constraints had a lower average amount of cost growth from initial estimates compared to programs without a constraint. However, DOD's implementation of another key reform initiative—the fostering of competitive environments in acquisition—is stagnant. Compared to GAO's 2016 assessment, more programs this year reported having no plans for competition before or after development start. Lastly, 31 current programs reported that they are scheduled to complete the evaluation of their potential cyber vulnerabilities by 2019, required by the 2016 fiscal year National Defense Authorization Act.

Most of the programs GAO assessed this year are not yet fully following a knowledge-based acquisition approach, as GAO has previously recommended. This held true for the four programs that recently entered system development as only one completed all of the applicable GAO criteria for a best practices approach. Three of the four implemented some knowledge-based practices, such as completing a system-level preliminary design review before development start. Meanwhile, other practices, such as fully maturing technologies prior to system development start and completing systems engineering reviews, were not fully implemented. As a result, these programs will carry unwanted risk into subsequent phases of acquisition that could result in cost growth or schedule delays. In addition, a number of programs are concurrently conducting software and hardware development during production, further exposing programs to undue cost and schedule risk.

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Abbreviations

AMPV	Armored Multi-Purpose Vehicle
B-2 DMS-M	B-2 Defensive Management System Modernization
BMDS	Ballistic Missile Defense System
Columbia Class SSBN	Columbia Class Ballistic Missile Submarine
CIRCM	Common Infrared Countermeasure
DAMIR	Defense Acquisition Management Information Retrieval
DOD	Department of Defense
EELV	Evolved Expendable Launch Vehicle
eSRS	Electronic Subcontracting Reporting System
F-15 EPAWSS	F-15 Eagle Passive/Active Warning and Survivability System
F-22 Inc 3.2B	F-22 Increment 3.2B Modernization
IFPC Inc 2-I Block 1	Indirect Fire Protection Capability Increment 2–Intercept Block 1
JLTV	Joint Light Tactical Vehicle
KC-46A	KC-46A Tanker Modernization
LCS	Littoral Combat Ship
MDAP	Major Defense Acquisition Program
MRL	manufacturing readiness level
NA	not applicable
OASuW Inc 1	Offensive Anti-Surface Warfare Increment 1
PAC-3 MSE	Patriot Advanced Capability-3 Missile Segment Enhancement
PAR	Presidential Aircraft Recapitalization
SAR	Selected Acquisition Report
TBD	to be determined
TRL	technology readiness level
VH-92A	VH-92A Presidential Helicopter Replacement
WSARA	Weapon Systems Acquisition Reform Act

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U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
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Comptroller General
of the United States

March 30, 2017

Congressional Committees

I am pleased to present GAO's 15th annual assessment of the Department of Defense's (DOD) major defense acquisition programs. This report offers observations on the performance of DOD's current $1.46 trillion portfolio of 78 programs.[1] These 78 programs will require just over one quarter of all DOD's development and procurement funding over the next 5 years. This significant financial investment demands keen oversight and continued implementation of key legislative and policy reforms as well as knowledge-based best practices developed by GAO.[2] Over the past several years, we have found that many DOD programs have not uniformly implemented these reforms or best practices.

Our current assessment shows that the progress DOD has made since 2010 to decrease the amount of cost growth in its portfolio has now flattened out. When compared to last year's portfolio, the 2016 portfolio includes one fewer program but is estimated to cost nearly $9.4 billion more, as a majority of programs experienced cost increases over the past year. We also found that programs in the 2016 portfolio incurred an average delay in delivering capability of almost 2 months. More encouraging, we found that programs that started development after the implementation of the Weapon Systems Acquisition Reform Act of 2009 (WSARA) and DOD's "Better Buying Power" initiatives began in 2010 saw cost decreases over the past 2 years, indicating that recent reforms may be having a positive effect, though the decrease was not significant enough to avert an overall cost increase in the portfolio.

[1]Our assessment of DOD's portfolio does not include the cost of the Ballistic Missile Defense System (BMDS), as the program and its elements lack acquisition program baselines needed to support our assessment of cost and schedule change. For more information, on BMDS and its elements see GAO, *Missile Defense: Ballistic Missile Defense System Testing Delays Affect Delivery of Capabilities,* GAO-16-339R (Washington, D.C.: Apr. 28, 2016). 10 U.S.C. § 225 requires MDA to establish and maintain an acquisition baseline for certain elements of the BMDS, but these baselines are not the same as the acquisition program baselines developed pursuant to 10 U.S.C. § 2435 and DOD acquisition policies. For example, they do not include service-funded operations and sustainment costs needed to support GAO's assessment of cost and schedule change.

[2]See, e.g., Weapon Systems Acquisition Reform Act of 2009, Pub. L. No. 111-23.

Nonetheless, we found that new programs continue to implement only some of the knowledge-based best practices that are necessary at program start to provide sufficient knowledge as to whether a program is capable of meeting its performance requirements while also meeting its cost and schedule commitments. It is at program start that decision makers have the most leverage to ensure that the program exhibits desirable principles—namely, a match between its resources and requirements—before funding and approving the program. A program's technology maturity provides a key indicator of whether this match has been achieved. Our analysis also highlights other key points in the acquisition cycle where knowledge-based best practices should be better applied. For example, programs often hold major design reviews and enter production prior to demonstrating the product's design is stable and can be manufactured within cost, schedule, and quality targets. In addition, we also observed that nearly half the programs in the current portfolio fielded or planned to field initial capabilities prior to fully demonstrating those capabilities through operational test and evaluation. Programs doing this risk fielding systems that are later found to be ineffective or unsuitable for missions.

Weapon system acquisitions remain an area on GAO's high-risk list.[3] Continued efforts by DOD to mitigate these risks through adherence to best practices and effective program management are essential.

Gene L. Dodaro
Comptroller General
of the United States

[3]GAO, *High-Risk Series: Progress on Many High-Risk Areas, While Substantial Efforts Needed on Others*, GAO-17-317 (Washington, D.C.: Feb. 15, 2017).

U.S. GOVERNMENT ACCOUNTABILITY OFFICE

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March 30, 2017

Congressional Committees

In response to the joint explanatory statement accompanying the Department of Defense Appropriations Act, 2009, this report provides insight into the department's $1.46 trillion portfolio of major weapon programs.[1] This report also includes information related to small business participation pursuant to a mandate in a report for the National Defense Authorization Act for Fiscal Year 2013.[2] Additionally, this report's assessment of the Navy's Presidential Helicopter Program constitutes GAO's response to the annual reporting requirement for 2017 required by the National Defense Authorization Act for Fiscal Year 2014.[3]

This report includes observations on (1) the cost and schedule performance of DOD's 2016 portfolio of 78 major defense acquisition programs, (2) program implementation of key acquisition reform initiatives, and (3) the knowledge attained at key decision points in the acquisition process for 54 current and planned weapon programs.[4]

Our observations in this report are based on three sets of programs:

- We assessed 78 major defense acquisition programs in DOD's 2016 portfolio for our analysis of cost and schedule performance. We obtained cost, schedule, and quantity data from DOD's December

[1]See Explanatory Statement, 154 Cong. Rec. H 9427, 9526 (daily ed., Sept. 24, 2008), to the Department of Defense Appropriations Act, 2009, contained in Division C of the Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009, Pub. L. No. 110-329 (2008).

[2]H.R. Rep. No. 112-479, at 284 (2012). The National Defense Authorization Act for Fiscal Year 2013, Pub. L. No.112-239.

[3]The National Defense Authorization Act for Fiscal Year 2014, Pub. L. No.113-66, § 252 (2013).

[4]Major defense acquisition programs (MDAP) are those identified by DOD or with a dollar value for all increments estimated to require eventual total expenditure for research, development, test, and evaluation of more than $480 million, or for procurement of more than $2.79 billion, in fiscal year 2014 constant dollars. DOD has a list of programs designated as future major defense acquisition programs. These programs have not formally been designated as MDAPs; however, DOD plans for these programs to enter system development, or bypass development and begin production, at which point they will likely be designated as MDAPs. We refer to these programs as future or planned major defense acquisition programs throughout this report.

2015 Selected Acquisition Reports (SAR), which detail initial cost, schedule, and performance baselines as well as changes to baselines over the past year, and from the Defense Acquisition Management Information Retrieval Purview system, a DOD repository for program data. We assessed the reliability of the data by analyzing it and reviewing the steps officials take to ensure the system's data reliability, and determined that the data were sufficiently reliable for the purposes of our report.

- We assessed 45 major defense acquisition programs currently between the start of development and the early stages of production for knowledge attained at key decision points and their implementation of acquisition reforms. We obtained information on the extent to which the programs follow knowledge-based practices—identified by our past work included in the Related GAO Products section of this report—for technology maturity, design stability, and production maturity using two data-collection instruments. One was a questionnaire on issues such as systems engineering, design drawings, manufacturing planning and execution, and the implementation of specific acquisition reforms. The other was a data-collection instrument for determining schedule dates, critical technology levels, and other information. We received questionnaire responses from all 45 current programs from August through October 2016.
- We also assessed 9 future major defense acquisition programs not yet in the portfolio in order to gain additional insights into knowledge attained before the start of development and plans for implementation of key acquisition reform initiatives. We submitted a questionnaire to program offices to collect information on issues such as program schedule events, costs, and numerous acquisition reforms, and received responses from all 9 future programs from August through October 2016.

We present individual assessments of 54 programs—45 current and 9 future weapon programs.[5] These assessments include major defense acquisition programs currently in development or early production as well

[5]In addition to the 54 program assessments, we separately assessed the Navy's Frigate initiative, which is currently part of the Navy's Littoral Combat Ship program. We assessed the P-8A Poseidon Multi-Mission Maritime Aircraft Increment 3 as part of the 9 future major defense acquisition programs not yet in the portfolio. During the course of our review, we learned that DOD no longer plans to manage Increment 3 separately from the existing P-8A program. We will reflect this change in future assessments of the P-8A program.

as future programs. Appendix I contains detailed information on our scope and methodology.

We conducted this performance audit from April 2016 to March 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 the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

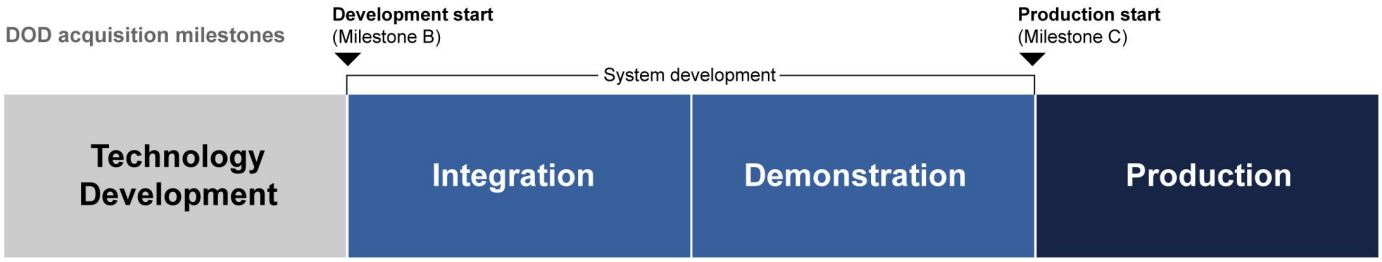
Background

DOD acquires new weapons for its warfighters through a management process known as the Defense Acquisition System.[6] This system generally requires defense acquisition programs to proceed through phases of development, which include a series of milestone reviews and other key decision points that may authorize entry into a new phase of acquisition. Once a decision has been made regarding the concept of the product to be acquired, the program may enter the initial phase of technology development, known as Technology Maturation and Risk Reduction. The purpose of this phase is to reduce technology, engineering, integration, and life-cycle cost risk to the point that a decision to contract for system development can be made with confidence in successful program execution for development, production, and sustainment. After that, the engineering and manufacturing development phase is to develop, build, and test a product to verify that all operational and derived requirements have been met, and to support production or deployment decisions. In this report, we refer to DOD's engineering and manufacturing development phase as system development. The final phase, before sustainment, is production and deployment, the purpose of which is to produce and deliver requirements-compliant products to receiving military organizations. In the production phase, the product is produced and fielded for use by operational units. Low-rate initial production, limited deployment, operational test and evaluation, and full rate production all occur in this phase. These various

[6]Department of Defense Directive 5000.01, *The Defense Acquisition System* (Nov. 2007); Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System* (Jan. 2015) ("DOD Instruction 5000.02"). An update to this instruction was released in January 2017, after we completed much of our analyses.

phases allow DOD to oversee and manage programs' development strategies and activities. Figure 1 illustrates the key milestones and reviews associated with the Defense Acquisition System.

Figure 1: Defense Acquisition System



Source: GAO analysis of Department of Defense (DOD) Instruction 5000.02. | GAO-17-333SP

Each year, DOD releases Selected Acquisition Reports (SAR) on the status of its major defense acquisition programs, including a comprehensive annual SAR that is generally submitted in conjunction with the submission of the President's Budget.[7] The cost estimates provided in the SARs include four types of funding: research and development, procurement, military construction, and acquisition-related operations and maintenance. These costs reflect actual costs to date as well as future anticipated costs. We use the SAR data to analyze and report on the progress of all of the current major defense acquisition programs, which we refer to as the current DOD portfolio. The DOD Instruction 5000.02 is implementing policy that describes the steps and procedures that programs generally follow as they proceed through the defense acquisition system. Since 2013, this instruction has incorporated certain 2010 acquisition reform initiatives.

DOD and Congress have previously addressed some of the challenges and problems in the defense acquisition system. Over the years, these entities have explored ways to improve acquisition outcomes. Most notably, the Weapon Systems Acquisition Reform Act of 2009 (WSARA) aimed to improve the organization and procedures of DOD for the acquisition of major weapon systems.[8] Among other things, WSARA revised the certifications that programs were expected to complete before being approved for system development start.[9] Programs are currently

[7]SAR reporting is statutorily required. 10 U.S.C. § 2432.

[8]Pub. L. No. 111-23.

[9]This requirement is codified as amended at 10 U.S.C. § 2366b.

required to make certain determinations and certifications that they have met the following requirements, among others, prior to entering system development:

- Appropriate trade-offs among cost, schedule, and performance objectives have been made to ensure the program is affordable;
- A preliminary design review and formal post-preliminary design review assessment have been conducted and, on the basis of such assessment, the program demonstrates a high likelihood of accomplishing its intended mission; and
- Technology has been demonstrated in a relevant environment on the basis of an independent review and assessment by the Assistant Secretary of Defense for Research and Engineering.

Since WSARA was implemented in late 2009, some of its requirements have been revised or repealed. The National Defense Authorization Act for Fiscal Year 2016 repealed the requirement for programs to conduct competitive prototyping prior to starting system development.[10] Now, acquisition strategies are to include competitive prototyping before starting system development, to the maximum extent practicable and consistent with the economical use of available financial resources, rather than required.

In 2010, DOD started its own acquisition reform initiatives in its "Better Buying Power" memoranda. These reforms include requiring programs to conduct affordability and "should-cost" analyses, among other things, which can result in placing cost constraints on programs and encouraging programs to find cost improvements during program execution. In addition, one of the initiatives in DOD's "Better Buying Power" memos is aimed at implementing practices and policies designed to improve the productivity of DOD and its industrial base. Many of the WSARA requirements and DOD initiatives have been incorporated into the DOD Instruction 5000.02. These and other reforms address sound management practices, such as realistic cost estimating, prototyping, and systems engineering. However, we previously found that the results of these reforms and initiatives might be limited if programs do not follow the

[10]Pub. L. No. 114-92, § 822(b).

knowledge-based best practices GAO has identified for product development.[11]

Observations on the Cost and Schedule Performance of DOD's 2016 Major Defense Acquisition Program Portfolio

Since our last report in 2016, our analysis shows that DOD's total planned investment in major defense acquisition programs increased by about $9.4 billion from $1.45 trillion to $1.46 trillion, whereas the number of programs decreased from 79 to 78. The cost increase represents a flattening to a trend of total acquisition cost decreases we observed each year from 2010 to 2015. We attribute this aggregate cost increase to cost growth affecting a majority of individual DOD programs over the past year, and, in particular, significant cost increases in a few large shipbuilding programs.

Our analysis also shows that the portfolio has experienced cost growth totaling over $484 billion since programs established their first full estimates; 60 percent of the cost growth occurred after programs started production. These significant post-production cost increases—particularly within development funds—may indicate that programs start production without having demonstrated that a fully integrated, capable, production-representative prototype will work as intended. Notably, $476 billion of this cost growth occurred in programs 5 or more years ago. Since 2011, the portfolio's cost has only grown by $8.6 billion. Based on our review of DOD estimates, the amount of future funding needed to complete the 2016 portfolio totals $573.6 billion, which is a decrease from the 2015 portfolio and is the lowest amount in over a decade. The decreased amount of future funding required indicates that more of the total cost of the portfolio has been spent.[12] Of the $573.6 billion, $546 billion is planned for procurement and $27.6 billion, or 5 percent of the total, is planned for development. Over the past 2 years, the portfolio has experienced a buying power gain. Further, the current portfolio's average

[11]GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, GAO-16-329SP (Washington, D.C.: Mar. 31, 2016).

[12]When we refer to spent funding, we are referring to funds that may have been expended, obligated, and, or allotted.

delay in delivering capability increased by almost 2 months over the past year, yet 49 percent of programs in the 2016 portfolio intend to declare, or have declared, initial operational capability on the basis of limited or, in a few cases, no operational testing.

Our analysis of DOD's 2016 portfolio allows us to make the following 11 observations:

Cost and Schedule Performance Observations

Changes to the portfolio

1. The 2016 portfolio consists of 78 programs, down from 79, which will cost over $1.46 trillion to acquire. Over the past year, the cost estimates of these programs increased by $9.4 billion, or less than 1 percent.[a]
2. Development and procurement costs increased by $3.7 and $5.6 billion respectively. Three programs—the Evolved Expendable Launch Vehicle, the Next Generation Operational Control System, and the Littoral Combat Ship—account for $2.2 billion of the aggregate development cost increase. The three largest procurement cost increases were in shipbuilding programs, which all increased their procurement quantities.
3. The amount of future funding needed to complete the portfolio's planned development activities and procure all planned units—$573.6 billion–decreased.[b] Of this future funding, $546 billion is for procurement and $27.6 billion is for development. The remaining funds for development total less than half the amount that remained 10 years ago. The current portfolio's average delay in delivering capability increased by almost 2 months over the past year.

Factors that explain the changes

4. The entire portfolio has experienced over $484 billion in cost growth since programs established their first full estimates. However, $476 billion of this growth occurred 5 or more years ago. The portfolio realized 60 percent of its cost growth, or $259 billion, after production start. These post-production cost increases may indicate that programs start production without having demonstrated that a production-representative prototype will work as intended. Programs started before 2010 make up a majority of the total cost growth since first full estimates.
5. The portfolio realized a buying power gain of $10.7 billion, although more programs overall lost buying power over the past year.[c]
6. As measured against specific cost growth metrics, 78 percent of programs meet the threshold for less than 10 percent cost growth over the past 5 years. However, fewer programs meet the metrics for realizing less than 2 percent cost growth over 1 year or for less than 15 percent cost growth from initial estimates.

Post-Reform Program Observations

7. Nineteen programs started development after the implementation of acquisition reforms in 2010. These programs decreased their costs by $3.4 billion over the past year—continuing a trend that began in 2015—but experienced an average delay to delivering capability of over 3 months.
8. These 19 programs represent about one-quarter of the programs in the whole portfolio, but account for only 10 percent of the portfolio's total acquisition cost.
9. Over the past year, total acquisition cost changes for these 19 programs show a similar profile to the cost changes affecting the remaining 59 programs. Further, an inordinately large program in each group—Joint Light Tactical Vehicle and F-35

Lightning II—drives a majority of the overall cost changes.

Other Observations

10. Forty-nine percent of programs intend to or have declared initial operating capability on the basis of limited or, in a few cases, no operational testing. Specifically, 9 percent declared initial operating capability before beginning testing, and 40 percent did or plan to declare initial operating capability before testing completes. Programs declaring initial operational capability prior to completing initial operational test and evaluation risk fielding systems that are later found to be ineffective or unsuitable for missions.

11. The leading companies DOD relies on to develop and produce military capabilities have consistently shown strong market performance, which indicates that investors expect the performance of these companies to be strong for some time to come. Stock prices for these companies have increased significantly over time—outperforming other market sectors over the past 1 year and 5 years.

Source: GAO analysis of DOD data. | GAO-17-333SP

[a]All dollar figures are in fiscal year 2017 constant dollars, unless otherwise noted.

[b]Details on program costs used for this analysis are provided in appendix I. For more information on the portfolio's performance since their estimates 1 year and 5 years ago, see appendix II.

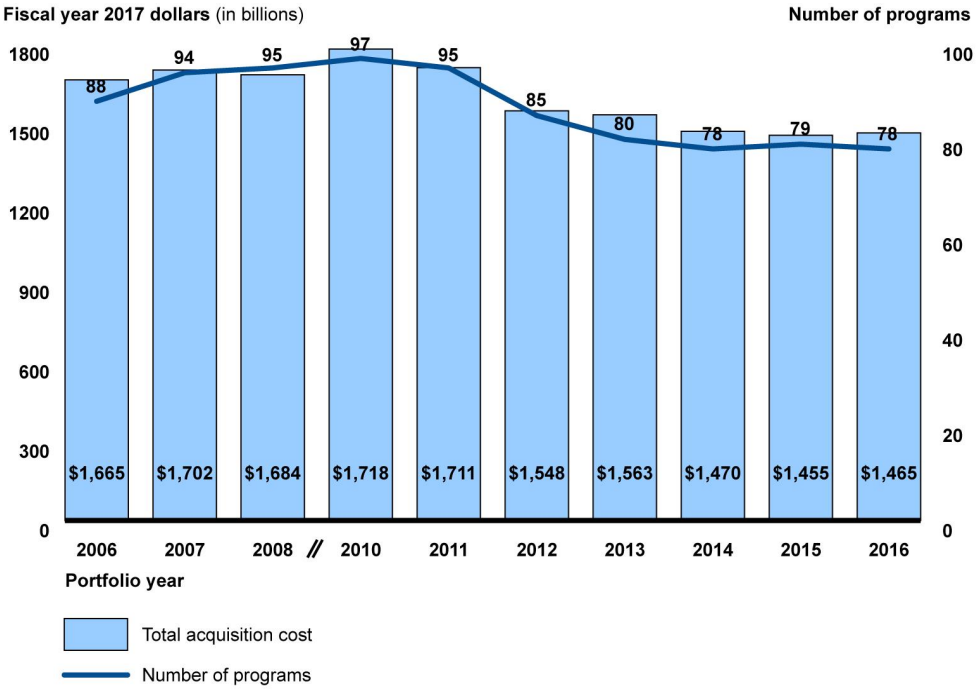
[c]Buying power can be defined as the amount of goods or services that can be purchased given a specified level of funding.

Changes to the portfolio

1. **The 2016 portfolio consists of 78 programs, down from 79, which will cost over $1.46 trillion to acquire. Over the past year, the cost estimates of these programs increased by $9.4 billion or less than 1 percent.** Our analysis shows that this cost increase is primarily due to three factors:

   - First, three programs left the portfolio—taking away $17 billion from the total cost—while two new programs expected to cost $16.9 billion in total entered the portfolio. Of the three programs that exited the portfolio, the Joint Tactical Networks and the RQ-4A/B Global Hawk Unmanned Aircraft System completed planned development and procurement. One program, the Joint Standoff Weapon, was terminated. Two Army programs began system development and entered the portfolio: the Armored Multi-Purpose Vehicle and the Joint Air-to-Ground Missile. The Joint Air-to-Ground Missile program was in the materiel solution and technology development phase before its system development start but the Armored Multi-Purpose Vehicle program entered development with its system development start in December 2014. Figure 2 shows the changes in total cost and number of programs within DOD's portfolio of major weapon acquisitions since 2006.

Figure 2: DOD Portfolio Cost and Size, 2006-2016

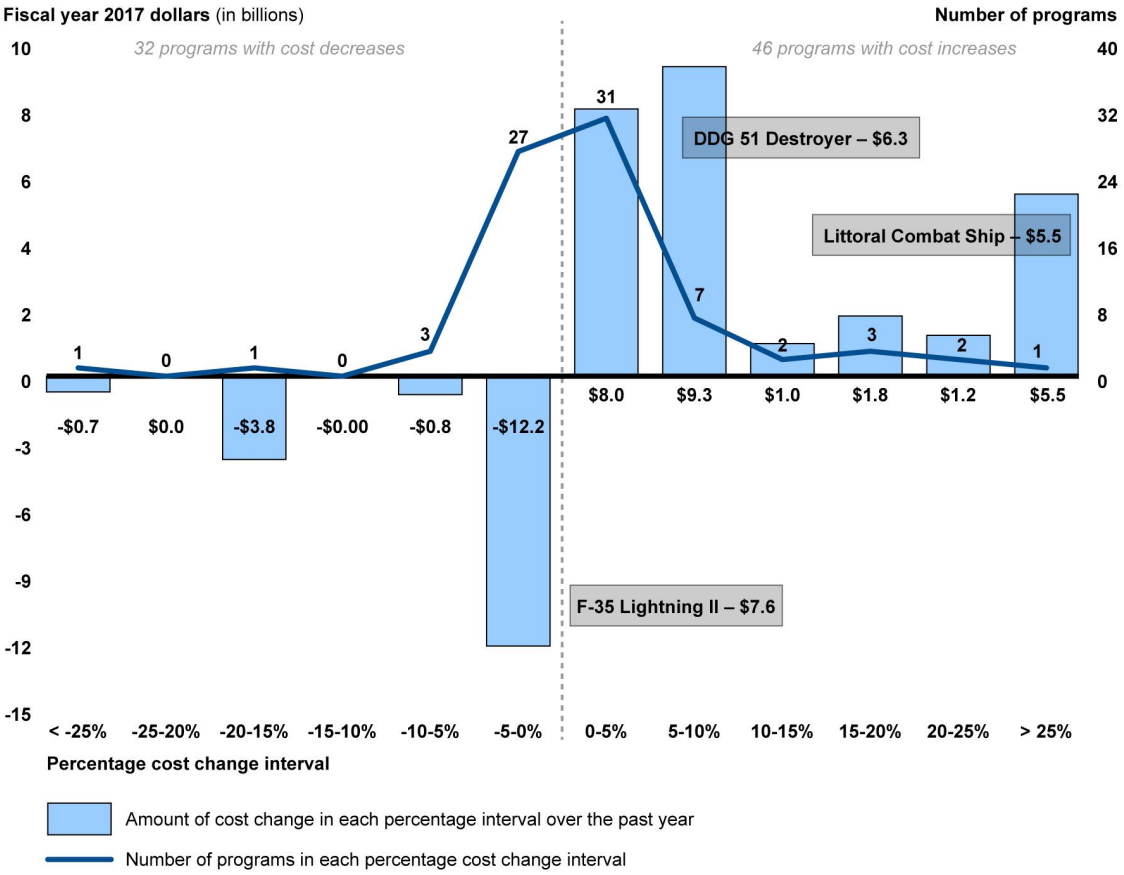


Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Note: DOD did not issue SARs in 2009, which precludes us from having the cost baseline information necessary to include 2009 in this analysis.

- Second, two of the portfolio's joint programs decreased their total cost significantly. The F-35 Lightning II's total cost decreased by $7.6 billion over the past year with no changes to its planned procurement quantities. Much of these savings were generated by changes in estimating assumptions for savings in future lots. The Joint Light Tactical Vehicle program decreased its total quantities and the total program's cost decreased by $3.8 billion not due to the quantity changes.
- Third, a majority of programs experienced cost increases over the past year. Of the 78 programs, 46 saw $26.8 billion in cost increases while 32 programs experienced $17.5 billion in cost decreases. Most programs' cost change over the past year were between a 0 to 5 percent change, whether it was an increase or a decrease. However, we identified a handful of programs with percent cost changes greater than 20 percent, including the Littoral Combat Ship and the Remote Minehunting System. Figure 3 shows the distribution of these cost changes across the entire portfolio.

Figure 3: Distribution of the 1-year Change in Total Acquisition Cost for the 2016 Portfolio



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Note: Any percentage that is an exact multiple of 5 is put in the higher category.

Of the 46 programs that experienced cost increases in the past year, 27 realized a total of $4.6 billion in increases that were not due to quantity increases. Another 18 programs saw their costs increase by $22.2 billion while also increasing their planned quantities. One program—the Joint Air-to-Surface Standoff Missile had a cost increase of $59.7 million, but also a quantity decrease.

Of the 32 programs that experienced cost decreases in the past year, 24 realized a total of $10 billion in decreases that were not due to quantity decreases. Another 7 programs saw decreases of $6.8 billion due to quantity decreases, while one program—AIM-120 Advanced Medium Range Air-to-Air Missile—had a cost decrease of $654.7 million despite an increase in quantity.

2. **Development and procurement costs increased by $3.7 and $5.6 billion, respectively. Three programs—the Evolved Expendable Launch Vehicle, the Next Generation Operational Control System, and the Littoral Combat Ship—account for $2.2 billion of the aggregate development cost increase. The three largest procurement cost increases were in shipbuilding programs, which all increased their quantities.** Table 1 outlines the changes in funding for the 2016 portfolio.

Table 1: Changes in DOD's 2016 Portfolio of 78 Major Defense Acquisition Programs over the Past Year Fiscal year 2017 dollars (in billions)

	Estimated portfolio cost in 2015	Estimated portfolio cost in 2016	Estimated cost change since 2015	Percentage change since 2015
Total estimated research and development cost	286.0	289.7	3.7	1.3
Total estimated procurement cost	1,156.3	1,162.0	5.6	0.5
Total estimated acquisition cost[a]	1,455.4	1,464.7	9.4	0.6

Source: GAO analysis of DOD data. | GAO-17-333SP

Note: Some numbers may not sum due to rounding.

[a]In addition to research and development and procurement costs, total acquisition cost includes acquisition-related operation and maintenance and system-specific military construction costs.

The current portfolio's development and procurement cost increases over the past year resulted in a total increase of $9.4 billion. Of the 78 programs, 52 increased their development costs over the past year. Increases for 18 of these programs were under $10 million each, and the remaining range between $10 million and $1.1 billion.

The three largest development cost increases included two space programs and one shipbuilding program. The largest development cost increase was on the Evolved Expendable Launch Vehicle program. Its cost increased by $1.1 billion to conduct new engine development activities. The Next Generation Operational Control System's costs increased by $575 million to address technical issues in its development. Further, Littoral Combat Ship development costs increased by $469 million to fund engineering support, test and evaluation, and training development needs in support of its new frigate-related design enhancements.

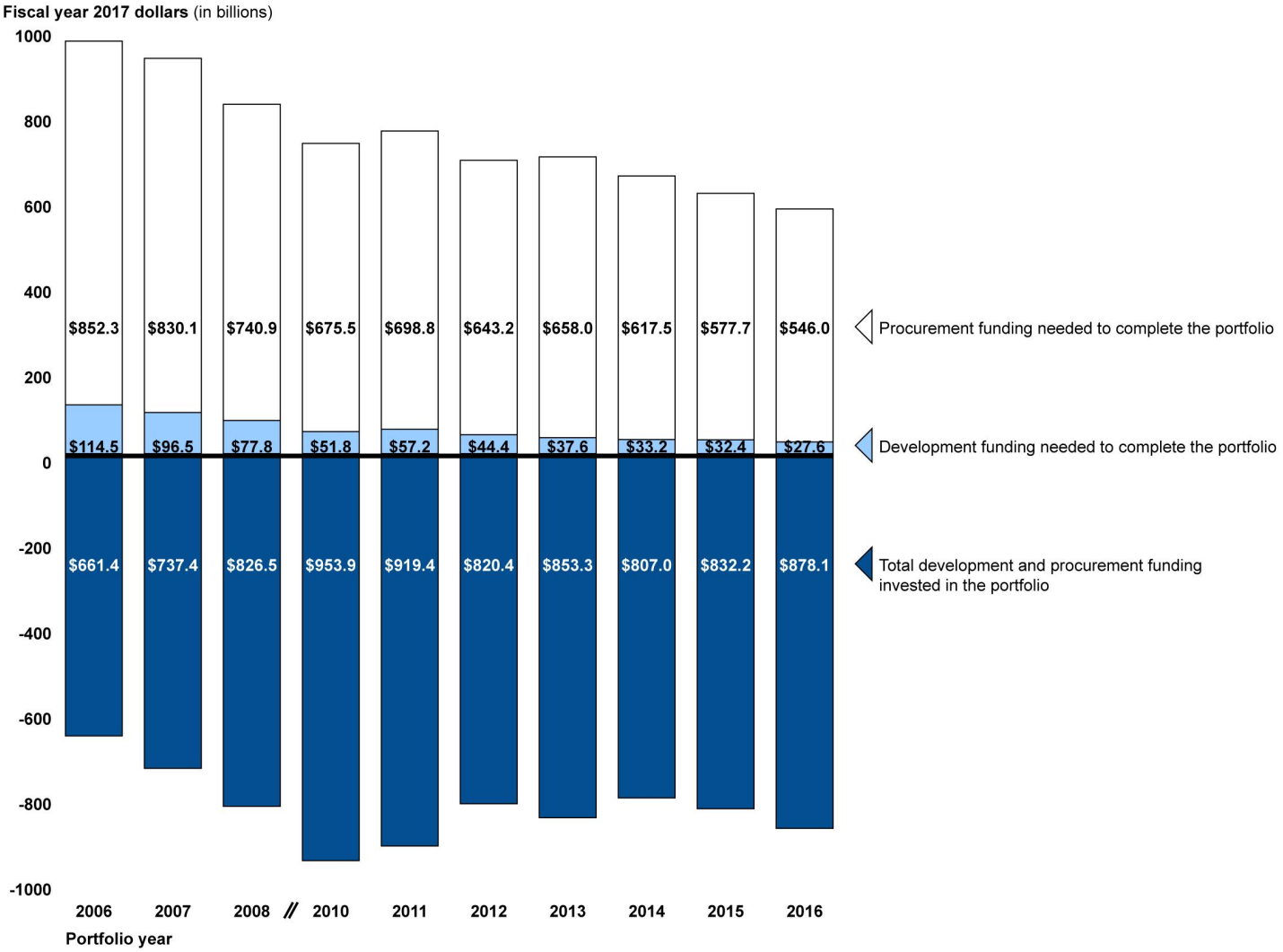
Three shipbuilding programs increased the quantity of ships they plan to buy, which increased their procurement costs and, subsequently, total acquisition costs significantly. Total acquisition costs for the DDG 51 Arleigh Burke Class Guided Missile Destroyer, the Littoral Combat

Ship, and the SSN 774 Virginia Class Submarine increased by $6.3 billion, $5.5 billion and $3.4 billion, respectively. These increases are in contrast to the decreases in procurement costs and total acquisition costs that we observed in our 2016 assessment.

3. **The amount of future funding needed to complete the portfolio's planned development activities and procure all planned units—$573.6 billion—decreased. Of this future funding, $546 billion is for procurement and $27.6 billion is for development. The remaining funds for development total less than half the amount that remained 10 years ago.[13] The current portfolio's average delay to delivering capability increased by almost 2 months over the past year.** The aforementioned cost changes indicate that more of the portfolio's total acquisition cost is spent and unavailable for allotment. The future funding available to conduct planned development activities and acquire expected units is 40 percent of the total development and procurement funding in the current portfolio. By contrast, in 2006, the amount of future funding available was over $966 billion, or 59 percent, of the portfolio's total development and procurement cost. Figure 4 shows the change in the portfolio's future funding and funding invested as a share of the portfolio's total acquisition cost since 2006.

[13]Other costs include military construction and acquisition operations and maintenance, which account for $13.1 billion of the 2016 portfolio's total acquisition cost.

Figure 4: DOD Portfolio Future Development and Procurement Funding in Comparison to Invested Funding by Year, 2006-2016



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Note: DOD did not issue SARs in 2009, which precludes us from having the cost baseline information necessary to include 2009 in this analysis.

In addition, the amount of future development funding in the current portfolio is less than half of what it was 10 years ago. The $27.6 billion in future development funding is 4.8 percent of the available future funding, compared to the amount available in 2006, which was over 11.8 percent.

Some programs' costs increased due to schedule delays. When measuring the current portfolio's schedule performance over the past year, we found that initial operational capability delays increased by almost 2 months and now stand at 30.8 months cumulative beyond initial estimates.[14] Of the 78 programs in the 2016 portfolio, 11 suffered delays that contributed to the overall portfolio delay. Seven of these 11 programs reported a delay of 6 months or more—delays significant enough to require DOD to report them as a breach to the acquisition program baseline. The largest delay—2.5 years—was in the Remote Minehunting System program, which DOD has since canceled.

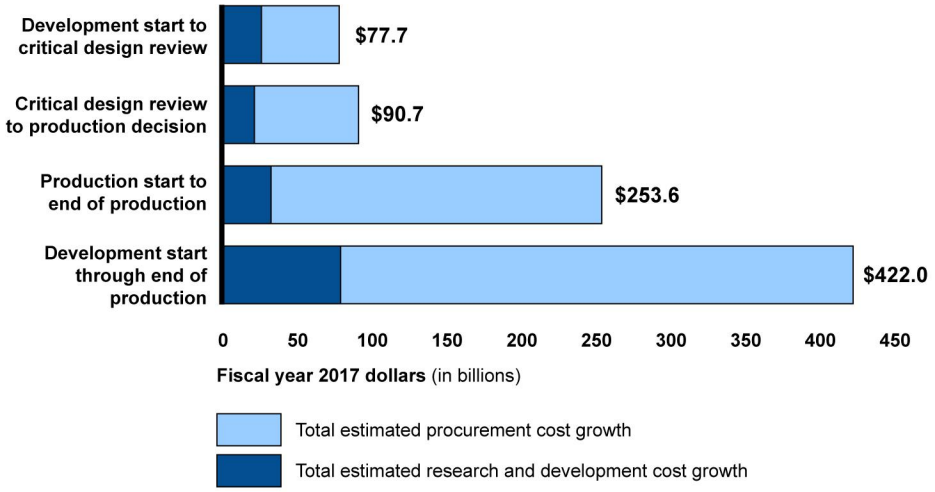
Factors that explain the changes

4. **The entire portfolio has experienced over $484 billion in cost growth since programs established their first full estimates.[15] However, $476 billion of this growth occurred 5 or more years ago. The portfolio realized a majority of its cost growth, or $259 billion, after production start. Programs started before 2010 make up a majority of the total cost growth since first full estimates.** At the start of system development and with the approval of the Milestone Decision Authority, programs establish an acquisition program baseline to measure their performance against. This baseline includes a cost estimate for the proposed solution that identifies estimated costs over the full life of the program, including development and production. Our analysis of the 2016 portfolio found that programs' costs grow throughout development, but that a majority of this cost growth occurs after programs have started production. Figure 5 illustrates the portfolio's development and procurement cost growth as incurred between key program milestones.

[14]When calculating this delay, we obtained schedule information for the cycle time from program start to initial operational capability as reported in the previous year and contrasted it with the current schedule.

[15]The first full estimate is generally the cost estimate established at the start of system development, for more information see Appendix I. For more information on the portfolio's performance since first full estimates, see Appendix III.

Figure 5: Development and Procurement Cost Growth between Key Milestones for Programs Included in DOD's 2016 Portfolio



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Note: To accommodate shipbuilding programs in this analysis, we correlated detail design contract awards, fabrication starts, and lead ship deliveries with development start, critical design review, and production start, respectively.

In the first phase of development, between the start of a program and critical design review, programs realized $77.7 billion in development and procurement cost growth, $25.7 billion of which was solely development cost growth. In the next phase, or between the critical design review and the initial production decision, programs realized an additional $90.7 billion in cost growth—$21 billion in development funding and $69.7 billion in procurement funding. Finally, after their production decisions, programs realized another $253.6 billion in cost growth, which is a 60 percent increase over their initial development and procurement estimates.

A majority of programs' development and procurement cost growth occurs after they have started production. These significant post-production cost increases—particularly within development funds—may indicate that programs start production without having demonstrated that a fully integrated, capable production-representative prototype will work as intended. Alternatively, post-production increases to procurement costs within programs may be explained, in part, by unplanned quantity increases.

5. **The portfolio realized a buying power gain of $10.7 billion, although more programs overall lost buying power over the past year.** To understand the changes in the portfolio's total cost over the past year, the effect of changes in quantity on individual programs

must be analyzed and understood. In general, buying power can be defined as the amount of goods or services that can be purchased given a specified level of funding. To determine changes in buying power, the effects of quantity changes must be isolated from other factors that affect cost. For example, a program's cost can increase solely because of additional quantities. While that does represent a cost increase, it does not necessarily indicate acquisition problems or a loss of buying power. Alternatively a program's cost can decrease due to a reduction in quantity and may still experience a buying power gain or loss. Table 2 shows our calculation of how programs' cost and quantity changes affected their buying power.

Table 2: Buying Power Analysis for the 2016 Portfolio Fiscal year 2017 dollars, billions

	Number of programs	GAO calculated cost change due to quantity changes	Actual procurement cost change	GAO calculated cost change not attributable to quantity changes
Programs that gained buying power	**33**	**1.8**	**-15.1**	**-16.9**
Procurement cost decreased with no quantity change	24	0.0	-13.6	-13.6
Quantity increased with less cost increase than anticipated	6	3.4	1.5	-2.0
Quantity decreased with more cost decrease than anticipated	3	-1.7	-3.1	-1.4
Programs that lost buying power	**40**	**14.6**	**20.7**	**6.2**
Procurement cost increased with no quantity change	25	0.0	2.6	2.6
Quantity increased with more cost increase than anticipated	12	15.8	19.2	3.4
Quantity decreased with less cost decrease than anticipated	3	-1.2	-1.1	0.2
Programs with no change in buying power	**5**	0.0	0.0	0.0
Portfolio totals	**78**	**16.3**	**5.6**	**-10.7**

Source: GAO analysis of DOD data. | GAO-17-333SP

Note: GAO calculated cost change "due" to quantity changes as the change in quantity over the last year multiplied by the average procurement unit cost and we calculated the cost change "not due" to quantity changes as the current acquisition quantity times the change in average per unit costs. If changes in quantity affect per unit cost, those changes will appear in the cost change "not due" to quantity changes column.

According to our calculation of cost versus quantity changes, we would have expected procurement costs in the portfolio to increase by $16.3 billion. Instead, procurement costs for the portfolio have increased by $5.6 billion over the past year, indicating that programs found efficiencies in other areas to offset the buying power losses. This net result is largely due to Army and Air Force programs gaining buying power and is offset by buying power losses in Navy programs.

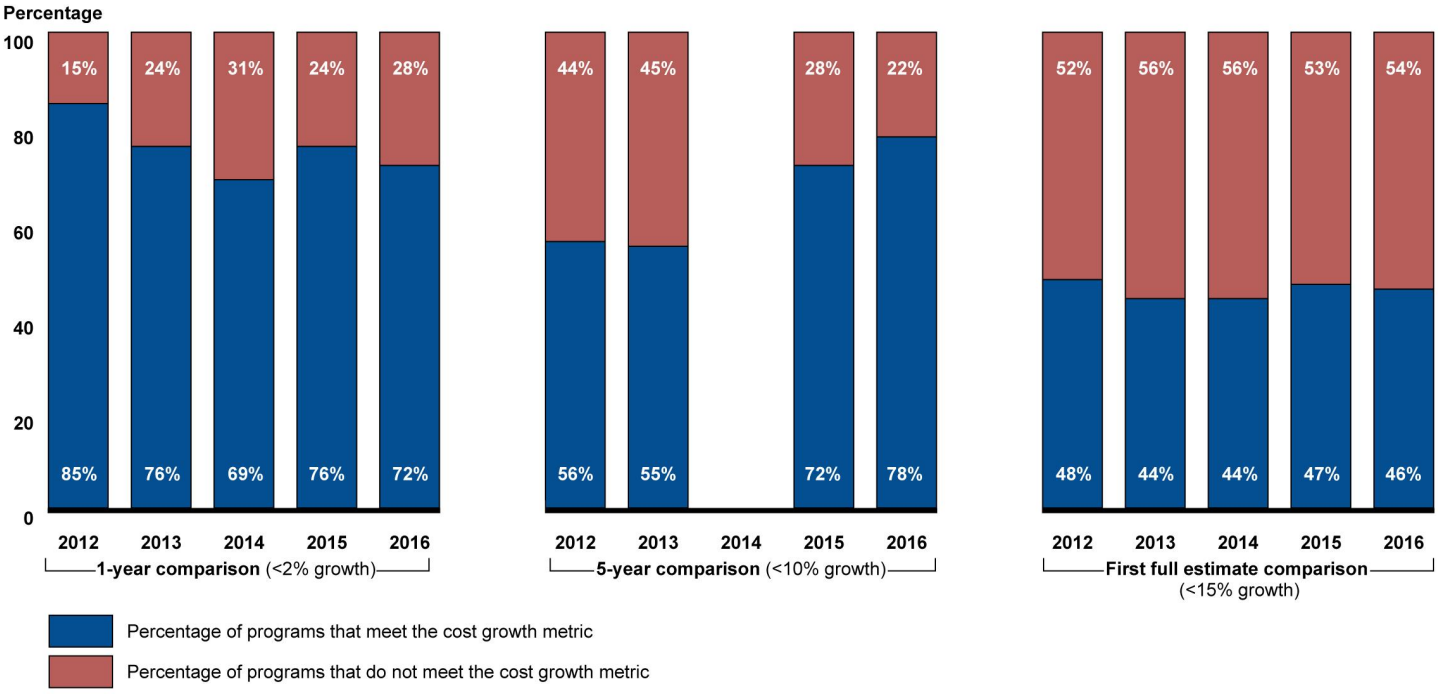
Our analysis shows that 33 programs increased in buying power over the past year and reduced procurement costs by a total of $15.1 billion. This total is the net amount of cost change given increases and decreases due to other program efficiencies. Twenty-four of these 33 programs decreased procurement costs with no change in their procurement quantity, indicating that they found efficiencies elsewhere. For example, the 2 DOD-lead programs—F-35 Lightning II and the Joint Light Tactical Vehicle—had significant decreases in total cost not due to quantity changes, which also drove the overall buying power gain. Some of these programs reported identifying significant realized and expected "should-cost" savings that resulted in a reduction of procurement cost or offset the cost of additional quantities.

Six programs are buying additional quantities at lower prices. In other words, their planned procurement quantities increased, but the corresponding procurement cost did not increase or was offset, at least in part, by other efficiencies. For example, the M109A7 Family of Vehicles program plans to procure 12 additional vehicles. Our analysis indicates that if the cost increase was what we expected, the program's procurement costs should have risen by $132 million. Instead, the program's procurement cost only increased by $123 million and the program realized a buying power gain.

Conversely, 40 programs lost buying power in the past year with actual procurement cost increases of $20.7 billion. By our calculations, the net result of quantity changes on these programs should have resulted in a $14.6 billion cost increase. Procurement cost increases not related to quantity changes generated $2.6 billion in additional costs and a net buying power loss. Contributing to this were 25 programs that lost buying power as their procurement costs increased with no change in quantities, an indication of inefficiencies within these programs. For example, the Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios program lost buying power as it experienced a procurement cost increase of $310 million over the past year with no change in its planned procurement quantity. Twelve programs increased their planned procurement quantities but incurred a higher than expected procurement cost increase, indicating that they lost efficiencies elsewhere. The remaining 3 programs reported decreases in their initial quantities; however, the cost reductions on these programs are less than expected by our calculations.

6. **As measured against specific cost growth metrics, 78 percent of programs meet the threshold for less than 10 percent cost growth over the past 5 years. However, fewer programs meet the metrics for realizing less than 2 percent cost growth over 1 year or for less than 15 percent cost growth from initial estimates.** In December 2008, we discussed and agreed with DOD and the Office of Management and Budget on a set of outcome metrics and goals to measure program cost performance over time. The metrics are intended to measure cost performance on a percentage basis over three defined periods: the preceding year, the preceding 5 years, and since first full estimates were established. We have reported on these outcomes since 2011 and figure 6 shows how the performance of the current portfolio compares to our prior assessments.

Figure 6: Comparison of the Cost Performance of DOD's 2012-2016 Portfolios



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Note: DOD did not issue Selected Acquisition Reports in 2009, which precludes us from having the cost baseline information necessary to assess the 5-year performance of the 2014 portfolio.

We found that 78 percent of programs kept their cost growth under 10 percent over the past 5 years, which is a six point improvement over the 2015 portfolio. The number of programs in the portfolio meeting this metric since 2013 has been increasing. While the 5-year trend is encouraging, less than half of the programs in the portfolio are able to

keep their cost growth under 15 percent from their initial cost estimates. Similarly, the number of programs in the 2016 portfolio that meet the 1-year metric by limiting their total acquisition cost growth to less than 2 percent decreased from 76 percent to 72 percent.

Post-reform program observations

7. **Nineteen programs started development after the implementation of acquisition reforms in 2010. These programs decreased their costs by $3.4 billion over the past year—continuing a trend that began in 2015—but experienced an average delay to delivering capability of over 3 months.** Since 2010, DOD has taken steps to improve the outcomes of defense acquisition programs including implementing the reforms in WSARA and DOD's "Better Buying Power" initiatives.[16] As a group, these 19 programs realized an overall cost decrease, but also a schedule delay. The cost decrease is primarily due to a large decrease on one program—the Joint Light Tactical Vehicle—and the net result of cost changes on the remaining 18 programs. During the past year, 9 programs reported cost decreases totaling $4.8 billion, while 10 programs reported cost increases totaling approximately $1.4 billion; together, this resulted in an overall cost decrease of $3.4 billion. Table 3 compares statistics for programs in the 2016 portfolio that began before 2010 (59) to statistics for the programs initiated in or after 2010 (19), once reforms were implemented.

Table 3: Observations on Programs Initiated before 2010 and in or after 2010 That Together Comprise DOD's 2016 Portfolio (All dollars in fiscal year 2017 dollars)

Programs initiated before 2010		Programs initiated in or after 2010	
Number of programs	59	Number of programs	19
Total acquisition cost	1.32 trillion	Total acquisition cost	147.1 billion
1-year cost change	12.8 billion increase	1-year cost change	3.4 billion decrease
Cost change since original estimate	486.3 billion increase	Cost change since original estimate	3.5 billion decrease
Percentage of programs with cost increases over the past year	61	Percentage of programs with cost increases over the past year	53
Total 1-year cost increases	25.4 billion	Total 1-year cost increases	1.4 billion
Percentage of programs with cost decreases over the past year	39	Percentage of programs with cost decreases over the past year	47

[16]Many of these reforms and initiatives have been incorporated into DOD Instruction 5000.02.

Programs initiated before 2010		Programs initiated in or after 2010	
Amount of 1-year cost decreases	12.6 billion	Amount of 1-year cost decreases	4.8 billion
Schedule accelerated over the past year	1.3 months	Schedule delay over the past year	3.1 months

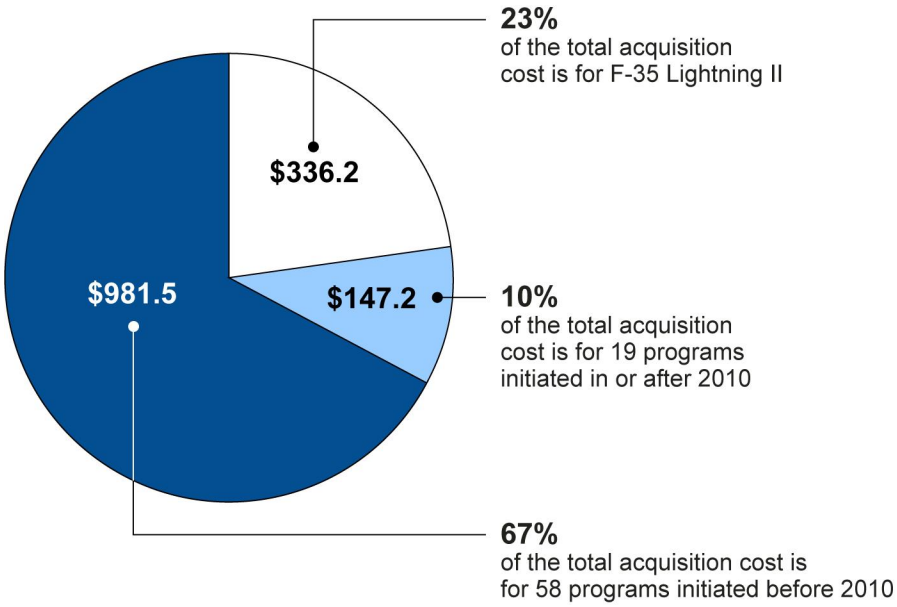
Source: GAO analysis of DOD data. | GAO-17-333SP

The total acquisition cost of the 59 and 19 programs, respectively, is $1.32 trillion and $147.1 billion. Of these amounts, $257.1 billion and $32.6 billion are development funding, or roughly 20 percent for each group of programs. Each group also had more programs with cost increases than not, and each generally had a similar percentage of programs with cost increases and decreases.

Of the 19 programs initiated in 2010 or later, 3 reported a delay of 1 year or more to their initial operational capability. The Next Generation Operational Control System, Joint Light Tactical Vehicle, and Small Diameter Bomb Increment II programs reported delays of 2 years, over 1 year, and 1 year respectively. We found that a similar proportion of programs initiated before 2010 also reported delays. Schedule delays may cause a program's cost to increase. However, delays may also indicate that the program recognizes it needs more time before exiting development to be ready to continue into later phases, such as testing and production.

8. **These 19 programs represent about one-quarter of the programs in the whole portfolio, but account for only 10 percent of the portfolio's total acquisition cost.** Many of the programs that started system development in or after 2010 may not have been in development long enough to realize similar cost growth as the rest of the portfolio. Nonetheless, all but 2 of these programs—the Combat Rescue Helicopter and the Intercontinental Ballistic Missile Fuze Modernization—have held a critical design review or started system development concurrent with a production decision and are now at a point in the acquisition cycle where other programs have experienced significant cost growth, as we identified above. Nine of the 19 programs held a critical design review in the past 3 years. The estimated cost for these 19 programs is less than half the cost of the F-35 Lightning II, as shown in figure 7 below.

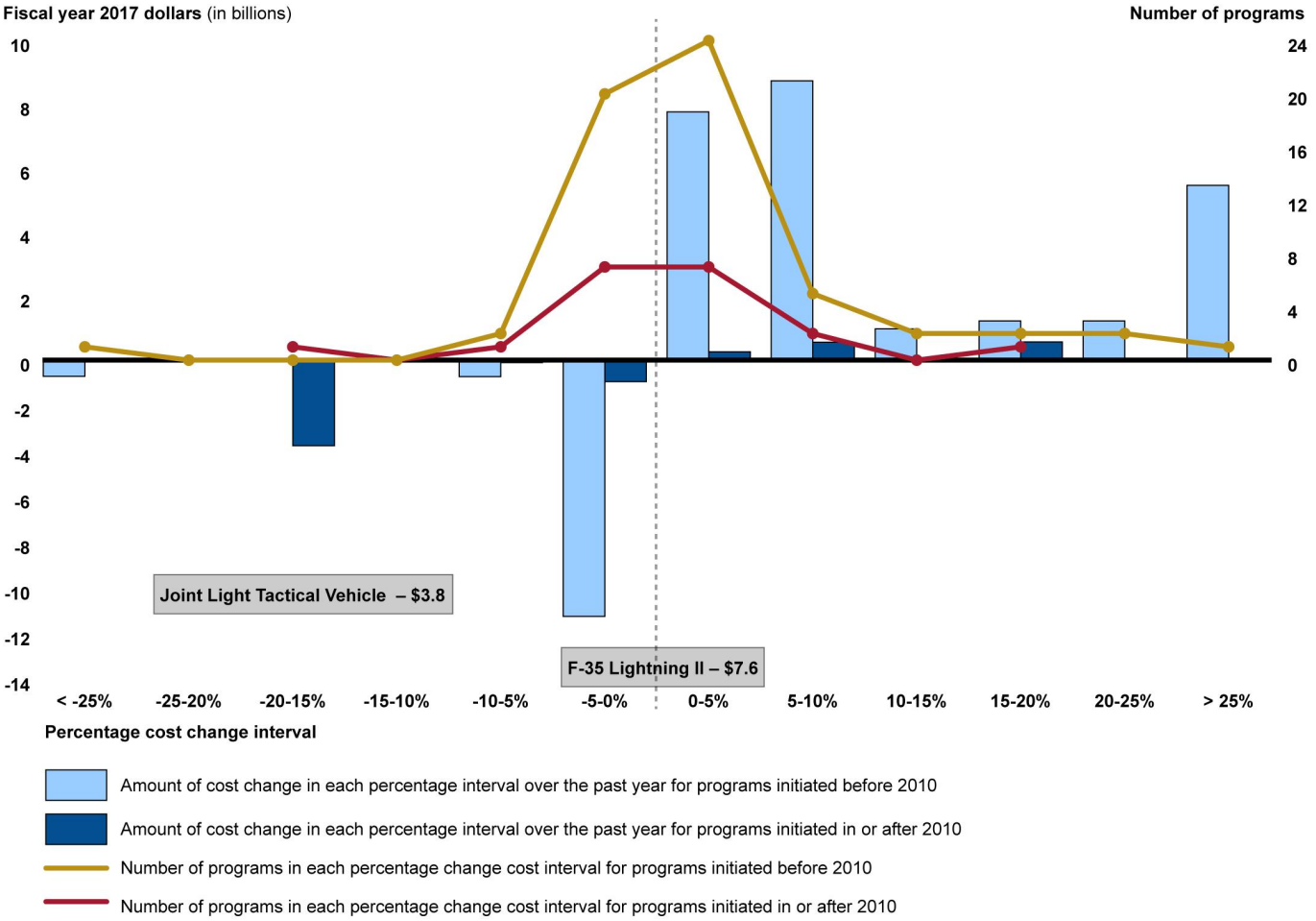
Figure 7: Ten Percent of DOD's Total Acquisition Cost Is for the 19 Programs Initiated in or after 2010 and 90 Percent Is for the Remaining 58 Programs and the F-35 Lightning II (fiscal year 2017 dollars in billions)



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

9. **Over the past year, total acquisition cost changes for these 19 programs show a similar profile to the cost changes affecting the remaining 59 programs. Further, an inordinately large program in each group—Joint Light Tactical Vehicle and F-35 Lightning II—drives a majority of the overall cost change.** We analyzed the cost and schedule changes for the 19 programs started after acquisition reforms to compare their performance as a group to the remaining 59 programs in the portfolio. We found that, in many ways, they are performing similarly in terms of cost. For example, a majority of programs in each group saw small percent changes in their total acquisition cost growth resulting in similarly shaped bell curves in figure 8. Figure 8 also illustrates the distribution of total acquisition cost change amount in each percent change interval over the past year for both sets of programs.

Figure 8: Distribution of the 1-year Change in Total Acquisition Cost for the Programs Initiated before 2010 and the Programs Initiated in or after 2010



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Note: Any percentage that is an exact multiple of 5 is put in the higher category.

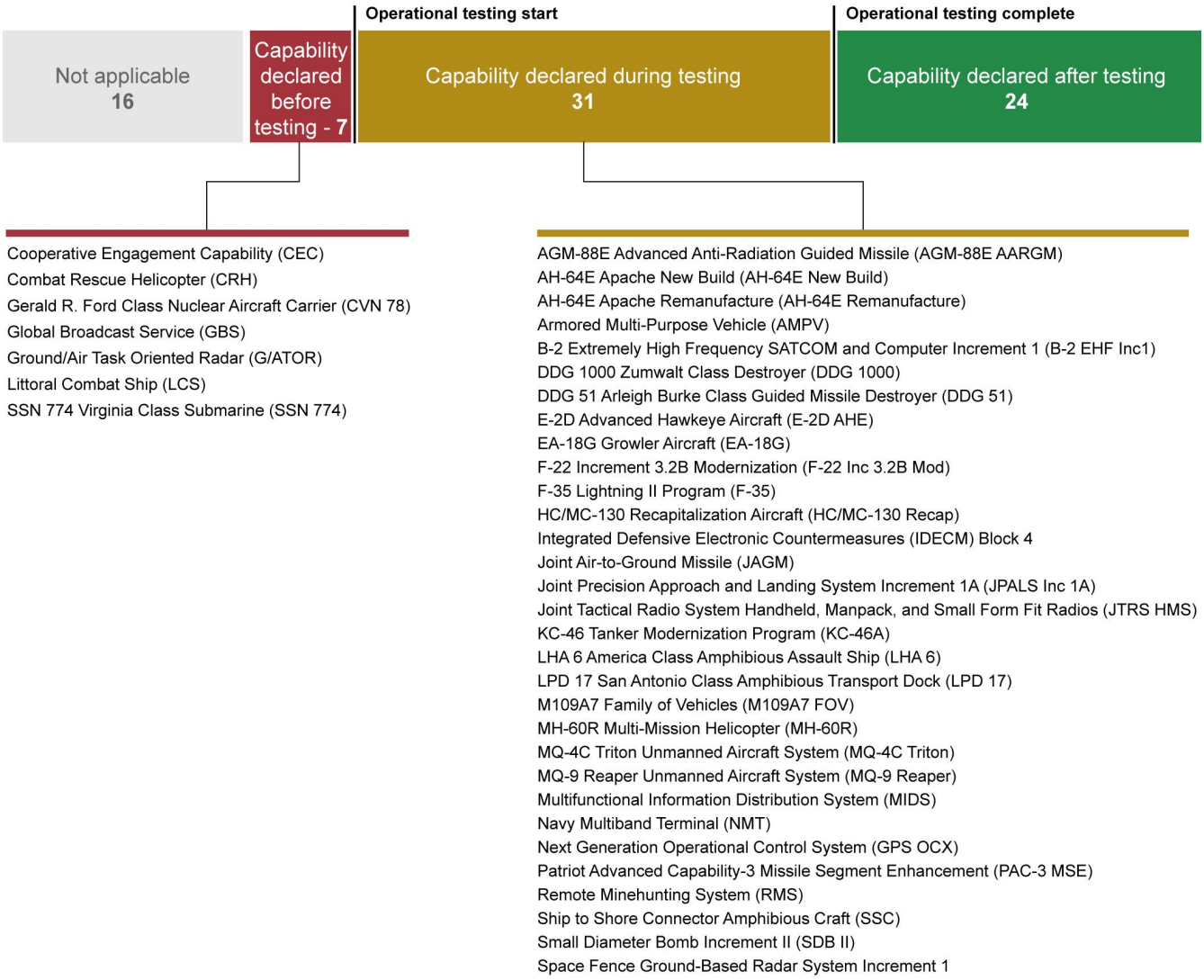
The distribution curve of each set of programs is similar with a majority of programs between a 5 percent decrease and 5 percent increase over the past year and only a few programs with large percent changes. We also identified the Joint Light Tactical Vehicle and F-35 Lightning II as outlier programs. These 2 programs had significant cost decreases over the past year that disproportionately affected the net cost change for their respective groups.

Other observations

10. **Forty-nine percent of programs intend to or have declared initial operational capability on the basis of limited or, in a few cases, no operational testing. Specifically, 9 percent declared initial operational capability before beginning testing, and 40 percent did or plan to declare initial operating capability before testing completes. Programs declaring initial operational capability prior to completing initial operational test and evaluation risk fielding systems that are later found to be ineffective or unsuitable for missions.** According to DOD policy, the appropriate authority will declare initial operational capability when the unit or organization has been equipped and trained and is determined to be capable of conducting mission operations. The specifics for a particular system's initial operational capability are defined in its Capability Development Document and Capability Production Document, which DOD requires before a program enters system development and production, respectively. For instance, when drafting a Capability Development Document, programs describe the types and initial quantities of assets required to attain initial operational capability. They also identify the operational units such as the service or other government agencies that will employ the capability. Initial operational capability definitions in these documents, however, may or may not include the Director, Operational Test and Evaluation's assessment of the system's effectiveness and suitability.

    Typically, initial operational capability and operational test and evaluation both occur during a program's production and deployment phase. Initial operational test and evaluation is intended to evaluate a system's effectiveness and suitability under realistic combat conditions before a full-rate production decision. However, DOD's Instruction 5000.02 may be tailored to meet program objectives, and DOD's Test and Evaluation Management Guide notes that initial operational capability is usually determined by the service. Consequently, programs can declare initial operational capability on the basis of full, partial, or no initial operational test and evaluation. Our analysis found that nearly half the programs in the current portfolio declared, or plan to declare, initial operational capability before or during testing. Figure 9 illustrates our analysis of the relationship between initial operational capability and initial operational test and evaluation in current DOD programs.

Figure 9: Programs' Timing of Declaring Initial Operational Capability and Completing Initial Operational Test and Evaluation



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Note: The quantity allotments within the figure reflect programs that have declared initial operational capability as well as some that have not yet declared it, but have identified when they expect to make the declaration in relation to their initial operational test and evaluation plans.

Programs declaring initial operational capability prior to completing full operational testing risk finding deficiencies in testing that may need to be corrected, which could add to a program's cost and schedule post-production. For example, the Navy declared initial operational capability for the Littoral Combat Ship in 2014 while facets of the ship's capabilities—including most mission equipment—were still

undergoing developmental testing. Essentially, declaring initial operational capability signals that the ship is ready to conduct missions. However, in the case of the Littoral Combat Ship, we testified in December 2016 that the Navy had fallen short of demonstrating that either of the program's two seaframe designs, or its three mission packages, met the minimum level of capability defined at the beginning of the program.[17] Further, since declaring initial operational capability, the program has identified significant performance limitations affecting both seaframes and mission packages, consequently leading it to postpone initial operational test and evaluation. These deficiencies have contributed, in part, to the Navy truncating the program at fewer quantities than originally planned and moving to a new design frigate.

Although many programs are not utilizing their operational testing results to inform their initial capability declarations, some are. Thirty-one percent of programs either achieved or plan to achieve initial operational capability after they have completed operational testing. Sixteen programs either do not track an initial operational capability date or have completed or planned operational test dates.

11. **The leading companies DOD relies on to develop and produce military capabilities have consistently shown strong market performance, which indicates that investors expect the performance of these companies to be strong for some time to come. Stock prices for these companies have increased significantly over time—outperforming other market sectors over the past 1 year and 5 years.** These sustained increases have occurred irrespective of cost and schedule outcomes in the defense acquisition portfolio, which these companies help support. DOD relies on the defense industrial base to provide capabilities that equip forces to meet mission requirements. The defense industrial base consists of privately owned companies of various sizes to which DOD awards contracts to develop and produce its major weapon systems. The defense industrial base works in tandem with DOD to provide key capabilities to our warfighters.

    We observed that regardless of whether DOD programs experienced cost increases, decreases, or stability, nearly every leading defense contractors' stock price generally increased. This provides an indication that investors expect the performance of these companies

[17]GAO, *Littoral Combat Ship and Frigate: Slowing Planned Frigate Acquisition Would Enable Better-Informed Decisions*, GAO-17-279T (Washington, D.C.: Dec. 8, 2016).

to be strong for some time to come. We selected six publicly-traded defense contractors developing and delivering the largest DOD acquisition programs and analyzed their stock prices and their DOD programs' cost changes over the past year and 5 years.[18] These contractors account for 73 percent of the contracts for weapon systems in the current portfolio.

In comparison, these defense companies' stock prices have grown at consistently higher rates over the past year and 5 years than the S&P 500 and the Industrials sector of the S&P 500.[19] DOD also reported last year that its major defense companies have remained profitable, even in a DOD business environment that has increasingly attempted to more closely link contractor profits to performance in defense acquisition programs.[20]

Cost growth in the portfolio is undesirable from DOD's perspective as, in a constrained funding environment, DOD must make tradeoffs to fund cost growth on existing programs, rather than starting new programs or upgrading existing programs. For defense contractors, the effects of cost growth are partially determined by the type of contract awarded. A range of contract types may be used that vary the cost risk assumed by contractors and the government, depending on numerous factors. In addition, incentives can be used to incentivize the contractor to, among other things, control costs. DOD stated in its 2016 annual report on the performance of the Defense Acquisition System that, "the real issue is how effective the incentives are for each contract type based on the situation at hand."

For example, a DOD program may award a firm-fixed-price contract if the expected cost of the effort is well understood. A firm-fixed-price contract provides for a price that is not subject to change on the basis of the contractor's cost experience in performing the contract. This type of contract places most of the risk for cost growth on the contractor and provides incentive for the contractor to control costs and perform effectively. Some fixed-price type contracts provide for cost incentives. For example, we found in April 2015 that the KC-46A Tanker Modernization (KC-46A) program is being developed under a

[18]We did not include all defense contractors nor did we include any smaller defense contractors in our assessment.

[19]Indices used are based on Standard & Poor's Global Industry Classification System.

[20]Under Secretary of Defense, Acquisition, Technology, and Logistics, *Performance of the Defense Acquisition System: 2016 Annual Report* (Washington D.C.: Oct. 24, 2016).

fixed-price incentive (firm target) contract, which the Air Force awarded to Boeing in 2011 because it considered integrating largely mature military technologies onto an aircraft designed for commercial use to be a relatively low risk effort.[21] This contract type provides for adjusting profit and establishing the final contract price by application of a formula based on the relationship of total final negotiated cost to total target cost. The final price is subject to a price ceiling, negotiated at the outset, which is the maximum that may be paid to the contractor, except for any adjustment under other contract clauses. By December 2015, both the contractor and government estimated that costs would be over the contract ceiling price. As such, Boeing will generally assume all responsibility for the additional costs.

Alternatively, a program might award a cost-reimbursement contract if costs are less known and there is more risk for cost growth. The cost-plus incentive fee type contract is the most common cost-reimbursement contract type awarded in the current portfolio. Also, programs may use a combination of contract types to take advantage of the benefits each affords. Theoretically, no matter the contract type, if the contractor performs as expected, it should generally earn profits which could affect the contractors' stock prices. However, there are also cases in which the contractor may underperform, and subsequently earn fewer profits than expected.

The contractors in our analysis have business outside of their DOD contracts that also factor into their overall market performance. As such, we are not correlating the contractors' performance on their DOD contracts with their stock prices.

Observations about DOD's Implementation of Key Acquisition Reform Initiatives

In 2016, we found that more DOD programs were implementing WSARA acquisition reforms and "Better Buying Power" initiatives, which led to better acquisition outcomes on some programs.

In our work this year, we focused on aspects of WSARA and DOD's "Better Buying Power" initiatives that address program and portfolio

[21]GAO, *KC-46 Tanker Aircraft: Key Aerial Refueling Capabilities Should Be Demonstrated Prior to the Production Decision*, GAO-15-308 (Washington, D.C.: Apr. 9, 2015).

affordability, cost growth controls, and the use of competition throughout the acquisition life-cycle.

We found that the number of programs implementing reforms is similar or slightly less than what we have observed previously. For example, over the past year, 38 programs have conducted an affordability analysis and set affordability constraints whereas 16 have not. Also, a similar number of programs have conducted a "should-cost" analysis. These programs reported a larger total amount of realized and future expected "should-cost" savings than we observed previously, totaling $111.5 billion. This year, more programs than last year reported having no plans for competition at any point in their life cycle. Lastly, we assessed programs' plans to complete an evaluation of potential cyber vulnerabilities by 2019.

Our analysis allows us to make the following four observations concerning key acquisition reform initiatives:

Acquisition Reform Observations

1. Of the 54 current and future programs we assessed, 38 have established an affordability constraint while 16 have not. This is similar to our prior assessment. Thus far, all but one current program that conducted an analysis and set a constraint reported they are on track to remain within their constraints.
2. Of the 45 current programs, 42 conducted a "should-cost" analysis, and 41 of those reported anticipated savings of $111.5 billion; $23.6 billion of these savings have been realized to date. Programs we assessed were unable to account for the recipient of roughly half, or $11 billion, of the realized savings that they reported.
3. Current programs are conducting competitive prototyping at a higher rate than future programs plan to do. Further, of the 54 current and future programs we assessed, 41 plan to promote some means of competition during the acquisition cycle, while 13 have no plans for competition before or after development start.
4. Of the 45 current programs we assessed, 31 reported that they plan to complete an evaluation of potential cyber vulnerabilities by 2019.

Source: GAO analysis of DOD data. | GAO-17-333SP

1. **Of the 54 current and future programs we assessed, 38 have established an affordability constraint while 16 have not. This is similar to our prior assessment. Thus far, all but one current program that conducted an analysis and set a constraint reported they are on track to remain within their constraints.** One of the reform initiatives in DOD's "Better Buying Power" memoranda is conducting an affordability analysis that results in setting program cost constraints. This analysis differs from program cost estimates in that the constraint serves as a program requirement to ensure that it remains cost-effective.

   In accordance with DOD Instruction 5000.02, affordability constraints are intended to force prioritization of requirements, enable cost trades,

and ensure that unaffordable programs do not enter the acquisition process. When approved affordability constraints cannot be met, a program's technical requirements, schedule, and required quantities must be revisited. Failure to remain within these constraints may result in program termination.

Of the current and future programs we assessed, 38 of 54 have established an affordability constraint while 16 have not. This is a similar number of programs that had implemented affordability constraints in our last assessment.

Of the 16 programs that have not established an affordability constraint, 5 are future programs that have not completed development start at which point the constraints are put in place; 11 are current programs, 6 of which began system development before this requirement was established and one program that reported its development start as to be determined (TBD). One program, the Next Generation Operational Control System, responded that it does not currently expect to meet its affordability constraints.

While the effectiveness of these constraints has yet to be widely tested, we observed that the current programs we assessed with established affordability constraints had a lower average amount of cost growth from their initial estimates compared to programs without a constraint. Specifically, of the 45 current programs, 11 programs without a constraint saw their costs increase from initial estimates by $1.8 billion whereas the 34 programs with constraints saw their costs increase by $1.2 billion.

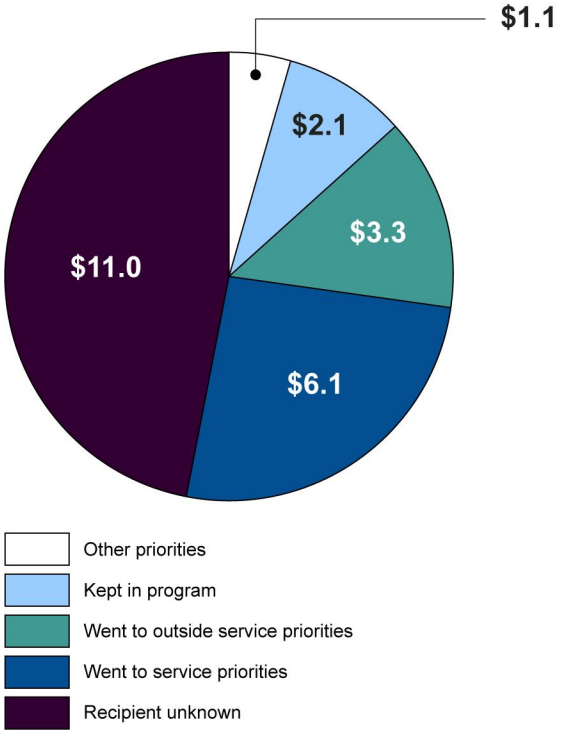
2. **Of the 45 current programs, 42 conducted a "should-cost" analysis, and 41 of those reported anticipated savings of over $111.5 billion; $23.6 billion of these savings have been realized to date. Programs we assessed were unable to account for the recipient of roughly half, or $11 billion, of the realized savings that they reported.** Stemming from DOD's "Better Buying Power" memoranda, and, in accordance with DOD Instruction 5000.02, each program must conduct a "should-cost" analysis resulting in an estimate to be used as a management tool to control and reduce cost. "Should-cost" analysis can be used to justify each cost under the program's control with the aim of reducing negotiated prices for contracts and obtaining other efficiencies in program execution to bring costs below those budgeted for the program. Any savings achieved can then be reallocated within the program or for other priorities.

Programs can do a variety of things that could lead to “should-cost” savings including multi-year pricing, acting as a system integrator, achieving more economical productions rates, reducing overhead, and improving supply chain management, among others. The 41 programs that reported anticipated “should-cost” savings most frequently cited the following activities as responsible for some of these savings, including:

- efficiencies realized through contract negotiations (14 programs),
- design trades to balance affordability and capability (11 programs), and
- developmental or operational testing efficiencies (10 programs).

Of the current 45 programs, 28 reported $23.6 billion in realized “should-cost” savings to date. Of this amount, $4.4 billion in savings accrued from reductions in development costs, $18.9 billion from reductions in procurement costs, and $0.2 billion from reductions in military construction and acquisition-related operations and maintenance costs. Programs also provided insights as to how their realized savings have been allocated, as shown in figure 10.

Figure 10: Recipients of the $23.6 Billion in Total Realized "Should-cost" Savings (Fiscal year 2017 dollars, in billions)



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Of the $23.6 billion in realized "should-cost" savings, programs could not identify where almost half, or $11 billion, of the total savings was transferred within DOD. DOD programs may not have strong incentives to continue to identify, realize, and report "should-cost" savings if those programs do not know what the funds are being used for, or if they perceive them as resulting in the funding of other DOD priorities. Of the $12.6 billion in realized savings for which programs could identify the recipients, $2.1 billion was kept within the programs to fund other priorities. Programs reported that $178 million of savings realized were used to offset budget cuts required by sequestration. Another $6.1 billion of the realized "should-cost" savings went to priorities within the military service to which the program belongs, and $3.3 billion went to priorities outside of the service.

Current programs that we surveyed expect to realize another $87.9 billion in future "should-cost" savings. Of this amount, programs expect $1.6 billion and $15.4 billion in savings to accrue within development and procurement funds, respectively. A majority of the future expected savings was reported as acquisition-related

operations and maintenance savings—totaling over $70 billion. Over $62 billion of the $70 billion was reported by the F-35 Lightning II program. In addition to the current programs, 3 of the 9 future programs reported having conducted a "should-cost" analysis and identified $7.5 billion in realized and future savings.

While most defense programs we assessed do not change their total cost estimates as a result of their "should-cost" analyses, 6 programs reported that their total cost estimate changed as a result of the savings identified, and 2 more programs are in the process of revising their cost estimate to account for their "should-cost" results.

3. **Current programs are conducting competitive prototyping prior to system development at a higher rate than future programs plan to do. Of the 54 current and future programs we assessed, 41 intend to promote competition at some point during the acquisition cycle, while 13 programs have no plans for competition before or after development start.** Competition is a critical tool for achieving the best return on the government's investment. Major defense acquisition programs are encouraged to include in their acquisition strategies the use of prototypes from two or more contractors before a program starts system development and have acquisition strategies that ensure the option of continued competition throughout the acquisition life cycle. According to DOD, the fostering of competitive environments is a central tenet in acquisition reform and the single best way to motivate contractors to provide the best value.

   Our prior work has shown that competitive prototyping can help programs reduce technical risk, refine requirements, and validate designs and cost estimates prior to making major commitments of resources.[22] The National Defense Authorization Act for Fiscal Year 2016 revised the requirement for programs to conduct competitive prototyping and instead emphasizes prototyping as an important risk mitigation approach.[23] We have found in the past that when programs require their contractors to build prototypes for early demonstrations of capability, the product developers complete a significant amount of systems engineering which leads to valuable knowledge that better

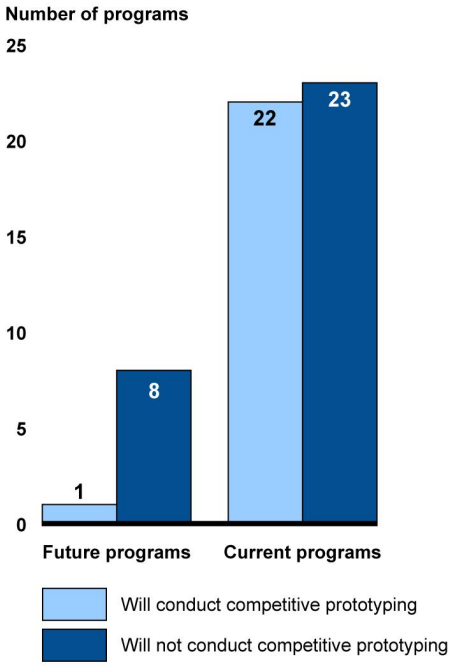
[22]GAO, *National Defense: Department of Defense's Waiver of Competitive Prototyping Requirement for the Navy's Fleet Replenishment Oiler Program*, GAO-15-57R (Washington, D.C.: Oct. 8, 2014).

[23]Pub. L. No. 114-92, § 822.

ensures that the requirements can be met within available resources.[24]

Of the 45 current programs, just under half conducted competitive prototyping. Yet, of the 9 future programs, only one identified plans to do so at the system or sub-system level before the start of system development. Programs not conducting competitive prototyping may be missing an opportunity to lower costs and reduce technical risk. Figure 11 shows how many current and future programs plan to conduct competitive prototyping.

Figure 11: Competitive Prototyping Plans among 54 Future and Current Programs



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Beyond competitive prototyping, many current and future programs identified plans to undertake additional measures to promote competition. However, compared to our 2016 assessment, this year more programs reported having no plans for competition before or after development start. Thirteen programs we assessed—6 future

[24] 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 Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, GAO-01-288 (Washington, D.C.: Mar. 8, 2001).

and 7 current programs—are not planning to take, or took no actions, to promote competition either before or after their development start dates. Table 4 outlines the extent to which current and future programs are planning to promote competition and in which phases of acquisition.

Table 4: Actions Reported by 54 Current and Future Programs to Promote Competition

	For the 9 future programs	For the 45 current programs	Total
Number of programs planning to promote competition	**3**	**38**	**41**
Throughout acquisition life cycle	1	15	**16**
Only prior to the start of system development	0	7	**7**
Only after the start of system development	2	16	**18**
Number of programs taking no actions to promote competition	**6**	**7**	**13**

Source: GAO analysis of DOD data. | GAO-17-333SP

4. **Of the 45 current programs we assessed, 31 reported that they plan to complete an evaluation of potential cyber vulnerabilities by 2019.** All defense acquisition programs containing Information Technology are required to have a cybersecurity strategy that is consistent with DOD policy and standards. In addition to this strategy, the National Defense Authorization Act for Fiscal Year 2016 requires the Secretary of Defense to complete an evaluation of the cyber vulnerabilities of each major weapon system of the Department of Defense by not later than December 31, 2019.[25] In 2016, DOD reported that it is making institutional and policy changes to address cybersecurity, among other things. Specifically, according to DOD, it is ensuring that cybersecurity regulations are applied to contracts to better secure controlled information in the defense industry.

   Six programs identified completion dates after December 31, 2019. These six consist of several programs early in development, including the Three-Dimensional Expeditionary Long-Range Radar, F-15 Eagle Passive/Active Warning Survivability System, and Next Generation

[25]Pub. L. No. 114-92, § 1647. The requirement may be fulfilled after 2019, or waived, if the Secretary certifies to the congressional defense committees that all known cyber vulnerabilities have minimal consequences for the capability of the weapon system to meet operational requirements or otherwise satisfy mission requirements.

Jammer Increments 1 and 2. Two additional programs identified completion dates that correspond with when they expect to complete operational testing—MQ-4C Triton Unmanned Aircraft System in 2021 and VH-92A Presidential Helicopter in 2020. Another program, the LHA 6 America Class Amphibious Assault Ship, currently in production and deployment, reported a date corresponding to the third ship of its class. Eight other programs did not provide dates identifying when, or if, they would complete evaluations of cyber vulnerabilities. One of these programs—the Air and Missile Defense Radar—reported that it is not scheduled to complete an evaluation.

Observations from Our Assessment of Knowledge Attained by Programs at Key Junctures

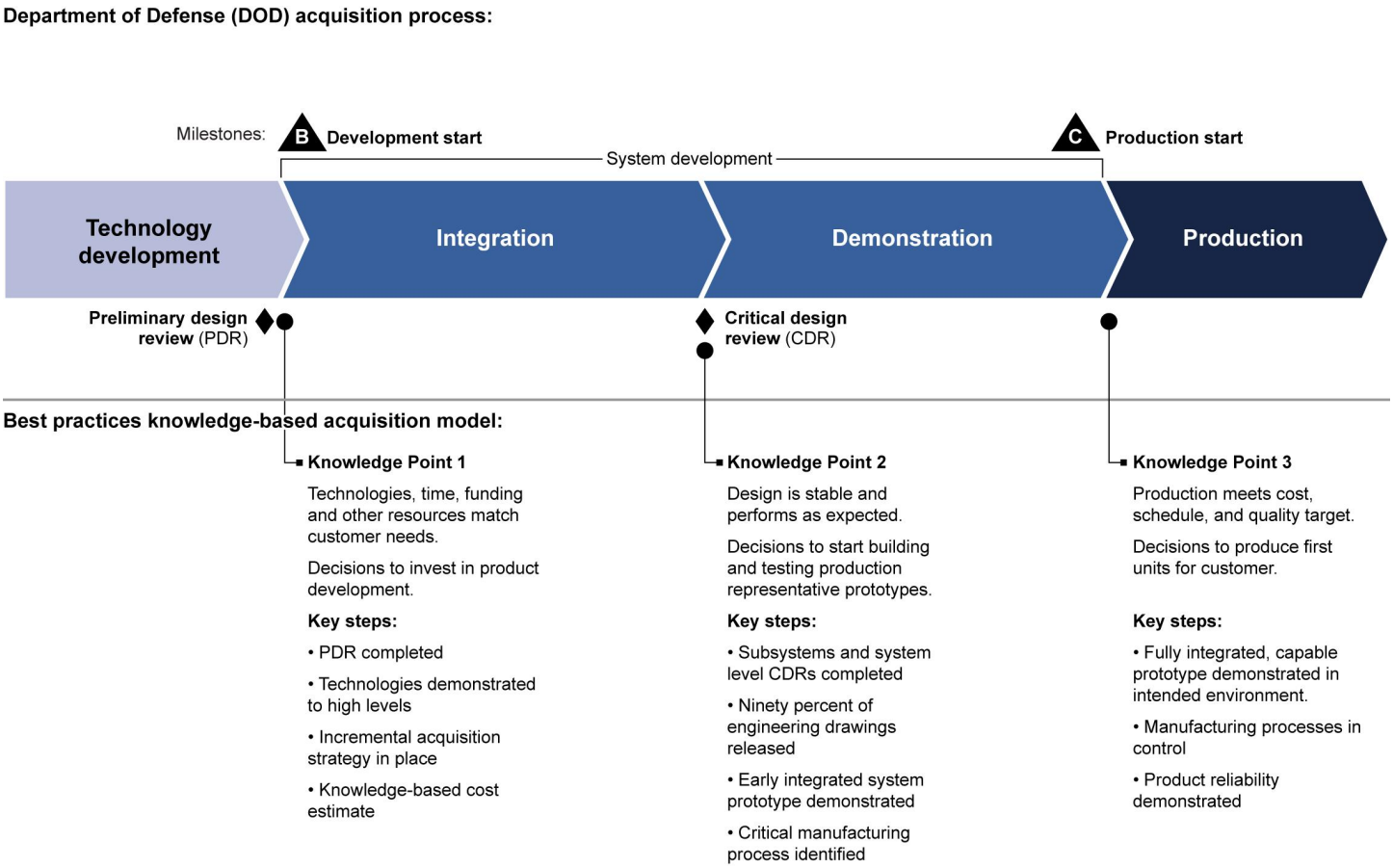
Our analysis found that although some programs are using knowledge-based practices to reduce acquisition risk, implementation continues to be inconsistent. For example, programs that recently began system development demonstrated some best practices—such as completing a system-level preliminary design review before committing resources. Others, however, are carrying technology risk well into system development, failing to demonstrate designs through prototyping, or proceeding into production before ensuring manufacturing processes are under control and developmental testing is complete.

Our body of work has shown that positive acquisition outcomes require the use of a knowledge-based approach to product development that demonstrates high levels of knowledge attained before significant commitments are made.[26] In essence, knowledge supplants risk over

[26]GAO, *Best Practices: DOD Can Achieve Better Outcomes by Standardizing the Way Manufacturing Risks Are Managed*, GAO-10-439 (Washington, D.C.: Apr. 22, 2010); *Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding*, GAO-09-322 (Washington, D.C.: May 13, 2009); *Defense Acquisitions: A Knowledge-Based Funding Approach Could Improve Major Weapon System Program Outcomes*, GAO-08-619 (Washington, D.C.: July 2, 2008); *Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes*, GAO-02-701 (Washington, D.C.: July 15, 2002); *Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, GAO-01-288 (Washington, D.C.: Mar. 8, 2001); and *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, GAO/NSIAD-99-162 (Washington, D.C.: July 30, 1999).

time. This work led to multiple recommendations that DOD has generally or partially agreed with and has made progress in implementing. On the basis of this work, we identified three key knowledge or decision points during the acquisition cycle—development start, system-level critical design review, and production start—at which programs need to demonstrate critical levels of knowledge to proceed. Figure 12 aligns the acquisition milestones described in DOD's primary acquisition policy with these key decision points.

Figure 12: Defense Acquisition Cycle and GAO Knowledge Points



Source: GAO analysis of DOD provided data, DOD Instruction 5000.02, and best practices. | GAO-17-333SP

As our prior work has shown, the building of knowledge consists of information that should be gathered at these three critical points over the course of a program.

Knowledge point 1: Resources and requirements match. Achieving a high level of technology maturity by the start of system development is one of several important indicators of whether this match has been made. This means that the technologies needed to meet essential product requirements should be form, fit, and function, integrated with other key supporting elements and have been demonstrated to work in a realistic environment. In addition, the developer should complete a series of systems engineering reviews culminating in a preliminary design of the product that shows the design is feasible. Constraining the development phase of a program to 5 or 6 years is also recommended because it aligns with DOD's budget planning process and fosters the negotiation of trade-offs in requirements and technologies. For shipbuilding programs, critical technologies should be matured into actual sub-system prototypes and successfully demonstrated in an operational environment before a contract is awarded for the detail design of a new ship.

Knowledge point 2: Product design is stable. This point occurs when a program determines that a product's design will meet customer requirements as well as cost, schedule, and reliability targets. A best practice is to achieve design stability at the system-level critical design review, usually held midway through system development. Completion of at least 90 percent of engineering drawings at this point provides tangible evidence that the product's design is stable, and a prototype demonstration shows that the design is capable of meeting performance requirements. Shipbuilding programs should demonstrate design stability by completing 100 percent of the basic and functional drawings, generally corresponding to a three-dimensional product model, by the start of construction for a new ship. Programs can also improve the stability of their designs by conducting reliability growth testing and completing failure modes and effects analyses so fixes can be incorporated before production begins. At this point, programs should also begin preparing for production by identifying manufacturing risks, key product characteristics, and critical manufacturing processes.

Knowledge point 3: Manufacturing processes are mature. This point is achieved when it has been demonstrated that the developer can manufacture the product within cost, schedule, and quality targets. A best practice is to ensure that all critical manufacturing processes are in statistical control—that is, they are repeatable, sustainable, and capable of consistently producing parts within the product's quality tolerances and standards—at the start of production. Demonstrating critical processes on a pilot production line is an important initial step in this effort. In addition, production and post-production costs are minimized when a fully

integrated, capable production-representative prototype is demonstrated to show that the system will work as intended in a reliable manner before committing to production. We did not assess shipbuilding programs for this knowledge point due to differences in the production processes used to construct ships.

Knowledge in these three areas builds over time. Our prior work on knowledge-based approaches shows that a knowledge deficit early in a program can cascade through design and production, leaving decision makers with less knowledge to support decisions about when and how to best move into subsequent acquisition phases that commit more budgetary resources. Demonstrating technology maturity is a prerequisite for moving forward into system development, during which time the focus should be on design and integration. A stable and mature design is also a prerequisite for moving forward into production, where the focus should be on efficient manufacturing. Additional details about key practices at each of the knowledge points can be found in appendix IV.

For this report, we assessed the knowledge attained at key junctures in the acquisition process for 45 current programs, which are mostly in development or early production.[27] Not all programs included in our review of knowledge-based practices provided information for every knowledge point and some had not reached all of the knowledge points—development start, design review, and production start—at the time of this assessment. We also reviewed the knowledge that 9 future major defense acquisition programs, as identified by DOD, expect to attain when they start system development in the coming years.[28] In addition, we analyzed the extent to which programs are undertaking concurrent developmental testing and production as well as their software development efforts to determine how they monitor and manage them.

Our analysis of the data from these current and future programs allows us to make the following five observations.

[27]Because knowledge points and best practices differ for shipbuilding programs, we exclude the six shipbuilding programs in DOD's portfolio from parts of our analysis at each of the three knowledge points. For more information, see appendix I.

[28]Information for these programs was collected from two data collection instruments distributed to program officials. See the "Analysis of Selected DOD Programs Using Knowledge-Based Criteria and Program Concurrency" section of appendix I for more information.

Knowledge Point and Program Concurrency Observations

1. Of the four programs that began or planned to begin system development during our assessment period, only one has demonstrated a total match between resources and requirements. One program plans to enter system development with immature technologies, one will have technologies approaching maturity, and two programs have not identified critical technologies to evaluate. Three of the programs completed a preliminary design review before development start. Two did not conduct all of the early system engineering reviews recommended by best practices. Two of four programs plan to constrain their development to less than 6 years.
2. Of the four programs that held or planned to hold a critical design review during our assessment period, none met all of the best practices. One of the programs has demonstrated mature technologies. While all programs plan to release at least 90 percent of drawings, three also do not plan to test a system-level integrated prototype. The implementation of best practices by these programs has degraded almost 40 percent from what we observed in 2016.
3. Of the three programs that held or planned to hold a production decision during our assessment period, none met all of the best practices. Two programs did not test a production-representative prototype before making a production decision, and only one of the three demonstrated processes on a pilot production line. The implementation of best practices at this juncture was mixed or slightly degraded compared to DOD programs' past implementation.
4. Eighteen programs in production plan to complete 30 percent or more of their developmental testing concurrent with production. Nine of these 18 programs plan to place more than 20 percent of their procurement quantities under contract before testing is complete.
5. Of the 54 current and future programs we assessed, 41 reported software development as a high-risk area. Despite this, almost half of the current programs do not separately price or track the cost of the software development efforts. Of the 45 current programs we assessed, 11 programs plan to start production prior to completing software development.

Source: GAO analysis of DOD data. | GAO-17-333SP

1. **Of the four programs that began or planned to begin system development during our assessment period, only one has demonstrated a total match between resources and requirements. One program plans to enter system development with immature technologies, one will have technologies approaching maturity, and two programs have not identified critical technologies to evaluate. Three of the programs completed a preliminary design review before development start. Two did not conduct all of the early system engineering reviews recommended by best practices. Two of four programs plan to constrain their development to less than 6 years.** Our prior work shows that the most critical juncture in any major defense acquisition is the decision to start system development, a point at which knowledge-based acquisition practices recommend having a match between what DOD wants in a weapon system, as defined by its

requirements, and the mature technologies, funding, schedule, and other resources needed to develop that system.[29] Figure 13 shows the extent to which DOD has implemented recommended acquisition practices for knowledge point 1 for the four programs that recently started system development or plan to do so in early 2017: F-15 Eagle Passive/Active Warning and Survivability System (F-15 EPAWSS), Indirect Fire Protection Capability Increment 2-Intercept Block 1 (IFPC Inc 2-I Block 1), the Columbia Class Ballistic Missile Submarine (Columbia Class SSBN) (formerly the Ohio Class Replacement), and the Presidential Aircraft Recapitalization (PAR)—as well as the other 41 current programs we assessed that previously accomplished this knowledge point.

[29]GAO, *Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, GAO-01-288 (Washington, D.C.: Mar. 8, 2001); and *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, GAO/NSIAD-99-162 (Washington, D.C.: July 30, 1999).

Figure 13: Implementation of Knowledge-Based Practices for Programs in System Development

Knowledge-based practices at system development start	Columbia Class SSBN	F-15 EPAWSS	IFPC Inc 2-I Block 1	PAR	Other 41 programs ●	Other 41 programs ○	Other 41 programs ––
Demonstrate all critical technologies are very close to final form, fit, and function within a relevant environment (TRL 6)	○	●	––	––	23	11	7
Demonstrate all critical technologies are in form, fit, and function within an operational environment (TRL 7)	○	○	––	––	3	29	9
Complete system functional review and system requirements review before system development start	○	●	●	○	15	25	1
Completed preliminary design review before system development start	●	●	●	○	19	21	1
Constrain system development phase to 6 years or less	––	●	●	––	27	6	8

● Practice implemented

○ Practice not implemented

––– Practice not applicable or information not available per the program office response

Columbia Class SSBN = Columbia Class Ballistic Missile Submarine
F-15 EPAWSS = F-15 Eagle Passive/Active Warning Survivability System
IFPC Inc 2-I Block 1= Indirect Fire Protection Capability Increment 2-Intercept Block 1
PAR = Presidential Aircraft Recapitalization

Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Demonstrate Technology Maturity

We assessed whether programs starting system development met two different best practices for technology maturity. First, federal statute requires that programs generally obtain a certification stating that technologies have been demonstrated within a relevant environment which as implemented means being very close to final

form, fit, and function.[30] Second, knowledge-based acquisition practices recommend that programs fully mature technologies and demonstrate them in an operational—or realistic—environment prior to starting system development. This is a higher level of technology maturity than required by law. Demonstrating technologies in an operational environment is a better indicator of whether a program has achieved a resource and requirements match, as it demonstrates the technologies' form, fit, and function as well as the effect of the intended environment on those technologies.

One program—the Columbia Class SSBN—does not plan to demonstrate all of its critical technologies in a relevant environment at the statutorily required level and has obtained a waiver to do so. Columbia Class SSBN is a program that will replace the Navy's current fleet of Ohio-class ballistic missile submarines. The program began system development in January 2017 and has identified two critical technologies. The Navy has subsequently determined that one is no longer a critical technology based on testing in a relevant environment. The other technology was assessed to be immature, but the program was granted a waiver from meeting this requirement. To mitigate the development risk, the Navy plans to share parts and components with the Virginia-class submarine, to the extent possible.

We also found that, of the four programs that began or were planning to begin system development in 2016, two programs had not fully matured their technologies and the other two did not identify any critical technologies. Fully mature technologies are defined as those that have been demonstrated in their final form, fit, and function within an operational environment with a prototype.

An independent review team, led by the Air Force Life Cycle Management Center determined that the F-15 EPAWSS program's technologies were approaching maturity at the start of system development, but were not fully mature by best practices. The program does not plan on attaining full maturity until after its

[30]Demonstration in a relevant environment is Technology Readiness Level (TRL) 6. Demonstration in an operational environment is TRL 7. See appendix V for detailed descriptions of TRLs. In addition, a major defense acquisition program generally may not receive approval for development start until the milestone decision authority certifies that the technology in the program has been demonstrated in a relevant environment. 10 U.S.C. § 2366b(a)(3)(D). Under certain circumstances, this requirement may be waived.

scheduled critical design review in March 2017. This delay leaves it at risk for flight test delays if the technologies do not mature as planned. The Army conducted a Technology Readiness Assessment for the IFPC Inc 2-I Block 1 program that identified no critical technologies at the start of its system development. This is due to the maturity of the program's sub-systems, which have already been fielded or are in production. Since IFPC Inc 2-I Block 1 and the PAR programs do not have critical technologies, we did not evaluate them for this best practice. The Columbia Class SSBN technologies are immature as the program begins system development, as the Navy has not demonstrated all technologies in an operational environment. As our prior work on shipbuilding best practices has shown, this strategy introduces risk for cost and schedule growth in the program.[31]

Of the remaining 41 programs, just 3 reported that all of their critical technologies were mature to best practices—in other words, demonstrated in an operational environment—when they began development, while 23 programs reported that their technologies were nearing maturity. Among all programs in our assessment, just 7 percent began system development with fully mature technologies.

DOD acquisition reforms included in WSARA and DOD's "Better Buying Power" initiatives are intended to improve acquisition procedures. We examined whether programs started before or after the implementation of these initiatives met the best practice to have mature technologies and their subsequent levels of cost growth. To do so, we assessed (1) whether the 45 programs started development before or after implementation of WSARA; (2) what their level of technology maturity was at that time; and (3) their development cost growth. Of the 45 programs, 19 were started before the implementation of WSARA, 25 were started after, and one did not have a system development start. Nine of the 19 programs that started before the implementation of WSARA began development with immature technologies. These 9 programs include 3 shipbuilding programs— CVN 78 Gerald R. Ford Class Nuclear Aircraft Carrier, DDG 1000 Zumwalt Class Destroyer, and Littoral Combat Ship—as well as the CH-53K Heavy Lift Replacement Helicopter, the F-35 Lightning II, Joint Tactical Radio System Handheld, Manpack, and

[31]GAO, *Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding*, GAO-09-322 (Washington, D.C.: May 13, 2009).

Small Form Fit Radios, Littoral Combat Ship Mission Modules, Patriot Advanced Capability-3 Missile Segment Enhancement, and the Warfighter Information Network-Tactical Increment 2 programs. These programs met almost none of the development start best practices recommended in our body of work. Since they began system development, as a group they have realized almost $35 billion in development cost growth. In contrast, 5 of the programs that started before implementation of WSARA began development with nearly mature or fully mature technologies and have realized $1.6 billion in development cost growth, a significant difference from that of the programs with immature technologies at development start. The remaining 5 programs did not report on the technology maturity at this point. This is a limited set of programs to analyze, but we have observed that those using fewer best practices realized significantly more cost growth. As a result, we believe that programs implementing more of the best practices in the future will continue to realize less cost growth.

Complete Systems Engineering Reviews before Development Start

Knowledge-based acquisition practices recommend that programs hold systems engineering events, including a system requirements review and a system functional review, before the start of system development:

- System requirements reviews ensure that requirements have been properly identified and that there is a mutual understanding between the government and the contractor.
- System functional reviews establish a baseline for the planned system.

We found that 2 programs completed these reviews prior to starting system development and 2 did not. The Columbia Class SSBN program held a system requirements review, but not the system functional review. The PAR program held neither review.

Regarding the use of this best practice on the other 41 programs we assessed, 37 percent held both reviews before system development start and 61 percent held neither or only one of these reviews before starting system development. This implementation rate is similar to

last year, in which 37 percent of the programs we reviewed held both reviews before development and 60 percent held neither.

Complete Preliminary Design Review before System Development Start

In addition to the engineering reviews, knowledge-based acquisition practices recommend the completion of a preliminary design review, before the start of system development to ensure that requirements are defined and feasible, and that the proposed design can meet those requirements within cost, schedule, and other system constraints. At preliminary design review is when a program should have completed sufficient systems engineering so as to establish an "allocated baseline"—essentially, definition of all subsystems and how they are to work together.

In a November 2016 report, we found that establishing a preliminary design through early detailed systems engineering portends better program outcomes than doing so after program start.[32] WSARA emphasized the value of defining an allocated baseline early by establishing a statutory requirement to conduct a preliminary design review prior to starting a development program or obtain a waiver to the requirement.[33] Among the 4 programs that started system development during our assessment period, all but one of them conducted this review before beginning system development. PAR obtained a waiver to this requirement and plans to hold its preliminary design review in April 2018, over a year and a half after its development start. Nineteen of the other 41 programs held a preliminary design review before the start of system development. Sixty-eight percent of programs that began development since the implementation of WSARA are implementing this practice compared to 26 percent of programs that began development before the

[32]GAO, *Weapon System Requirements: Detailed Systems Engineering Prior to Product Development Positions Programs for Success*, GAO-17-77 (Washington, D.C.: Nov. 17, 2016).

[33]Pub. L. No. 111-23, § 205(a). A major defense acquisition program may not receive milestone B approval until the program has held a preliminary design review and the milestone decision authority has conducted a formal post-preliminary design review assessment and certified on the basis of such assessment that the program demonstrates a high likelihood of accomplishing its intended mission unless a waiver is properly granted by the milestone decision authority. 10 U.S.C. § 2366b(a)(2), (d)(1).

implementation of WSARA, which is an improvement from last year's assessment.

Begin Future Programs with Adequate Knowledge

As part of our analysis, we assessed 9 future programs scheduled to become major defense acquisition programs in coming years. These programs provided information on the knowledge they planned to obtain and the best practices they intend to implement before their system development start is approved. Four identified critical technologies, 2 of which identified their anticipated maturity levels expected at system development start. One future program—the T-AO 205 John Lewis Class Fleet Oiler (formerly T-AO(X))—reported its critical technologies as fully mature in October 2014, almost 3 years before its planned development start. Two of the future programs reported that their critical technologies are expected to be nearing maturity and the remaining program reported that its critical technology maturity has not yet been determined for the time of their system development start.

Unlike the programs that held system development start in the past year, only 2 of the 9 future programs plan to hold a preliminary design review before the start of system development and only 3 programs plan to conduct both a system functional and system requirements review before that time. While all but one of the future programs currently plan to limit their system development phase to 6 years or less, these plans are preliminary and the programs are at risk of not satisfying all the knowledge-based practices we reviewed, leaving them at risk for cost and schedule growth, as table 5 indicates. The remaining programs reported that their critical technologies would not be fully mature or have not been identified. One program's technology maturity will be determined at system development start.

Table 5: Projected Implementation of Knowledge-Based Practices for Future Programs

	Development start	Projected to demonstrate all critical technologies in an operational environment	Projected to complete all systems engineering reviews	Plan to constrain system development
Long Range Precision Fires	TBD	—-	O	●
T-AO 205 John Lewis Class Fleet Oiler	06/2017	●	●	●

	Development start	Projected to demonstrate all critical technologies in an operational environment	Projected to complete all systems engineering reviews	Plan to constrain system development
P-8A Poseidon Multi-Mission Maritime Aircraft Increment 3	NA	—-	O	—-
MQ-25 Stingray Unmanned Air System	05/2018	—-	O	●
Joint Surveillance Target Attack Radar System Recapitalization	10/2017	—-	O	●
Improved Turbine Engine Program	TBD	O	O	●
Amphibious Ship Replacement	TBD[a]	—-	O	●
Advanced Pilot Training	12/2017	—-	O	●
Weather Satellite Follow-On	06/2018	O	●	●

● Implementation planned

O No implementation planned

—- Practice to be determined

Source: GAO analysis of DOD data. | GAO-17-333SP

Note: We assessed the P-8A Poseidon Multi-Mission Maritime Aircraft Increment 3 as part of the 9 future major defense acquisition programs not yet in the portfolio. During the course of our review, we learned that DOD no longer plans to manage Increment 3 separately from the existing P-8A program. We will reflect this change in future assessments of the P-8A program.

[a]The Amphibious Ship Replacement is by-passing system development and entering the DOD acquisition process in the production phase at a point which is to be determined.

Enforcing discipline and accountability at the start of development are essential for establishing satisfactory acquisition outcomes. Top decision makers need to ensure that programs will meet a knowledge-based approach before the programs are approved and funded. However, our observations show that the future programs plan to proceed without meeting these best practices which creates an environment where they are not held to DOD's standard, which makes successful acquisition outcomes unlikely.

2. **Of the four programs that held or are planning to hold a critical design review during our assessment period, none met all of the best practices. One of the programs has demonstrated mature technologies. While all programs plan to release at least 90 percent of drawings, three also do not plan to test a system-level integrated prototype. The implementation of best practices by these programs has degraded almost 40 percent from what we observed in 2016.** For this key milestone in a program's acquisition, we assessed eight best practices to determine the extent to which programs are attaining the knowledge needed for a low-risk acquisition. We have previously reported that programs that hold their

critical design review before achieving knowledge of a stable demonstrated design also experience higher average costs and longer schedule delays. Figure 14 shows the extent to which recommended acquisition practices for knowledge point 2 have been implemented for the four programs that recently finished their critical design review, or plan to in early 2017: Armored Multi-Purpose Vehicle (AMPV), Common Infrared Countermeasure (CIRCM), Offensive Anti-Surface Warfare Increment 1 (OASuW Inc 1), VH-92A Presidential Helicopter Replacement Program (VH-92A)—as well as the other 31 current programs we assessed, which previously accomplished this knowledge point.

Figure 14: Implementation of Knowledge-Based Practices for Selected Programs at Critical Design Review

Knowledge-based practices at critical design review	AMPV	CIRCM	OASuW Inc 1	VH-92A	Other 31 programs ●	Other 31 programs ○	Other 31 programs ––
Demonstrate all critical technologies in an operational environment	●	○	○	––	6	19	6
Release at least 90 percent of drawings	●	●	●	●	10	16	5
Test an early system-level integrated prototype	○	●	○	○	5	19	7
Establish a reliability growth curve	●	●	––	●	21	6	4
Identify key product characteristics	●	––	●	●	27	0	4
Identify critical manufacturing processes	●	––	●	●	25	1	5
Conduct producibility assessments to identify manufacturing risks for key technologies	●	––	●	––	24	2	5
Complete failure modes and effects analysis	●	●	●	●	24	1	6

● Practice implemented

○ Practice not implemented

––– Practice not applicable or information not available per the program office response

AMPV = Armored Multi-Purpose Vehicle
CIRCM = Common Infrared Countermeasure
OASuW Inc 1 = Offensive Anti-Surface Warfare Increment 1
VH-92A = VH-92A Presidential Helicopter Replacement Program

Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Demonstrate Technology Maturity

As product knowledge is cumulative, by the critical design review, programs should have demonstrated critical technologies in an operational environment to ensure that the product can meet requirements. Failure to fully mature technologies prior to developing the system design can lead to redesign and cost and schedule growth if later discoveries during development lead to revisions. Of all the knowledge-based acquisition practices programs strive to implement throughout the acquisition life cycle, this is one of the least utilized.

The OASuW Inc 1 program does not plan to meet this best practice before completing its critical design review. This program has six critical technologies; five are immature and one is approaching maturity, but none will be demonstrated in an operational environment at the time of the program's critical design review. Additionally, the CIRCM program identified seven critical technologies, which were not mature at the program's critical design review. The AMPV program is the only program with mature technologies that held a critical design review this year. The VH-92A program did not identify critical technologies at this juncture; therefore, we did not evaluate it for that practice.

To assess the effect of technology maturity on cost over time, we also examined the 19 programs that started development 7 or more years ago and the level of their technology maturity at the time of their critical design review. We found that of these 19 programs, 6 held their critical design review with immature technologies. These 6 programs have realized over $33 billion, or 63 percent, in development cost growth over their initial cost estimates. These include the same three shipbuilding programs mentioned in the previous section—CVN 78 Gerald R. Ford Class Nuclear Aircraft Carrier, Littoral Combat Ship, and DDG 1000 Zumwalt Class Destroyer—which started system development with immature technologies. They also include the F-35 Lightning II, M109A7 Family of Vehicles, and Patriot Advanced Capability-3 Missile Segment Enhancement programs. In contrast, 8 programs had fully mature technologies or nearly mature technologies at their critical design review. These 8 programs realized $4.7 billion, or 31 percent, in development cost growth, which is significantly less than the programs with immature technologies.

Demonstrate System Design Stability

All of the programs holding their critical design review in 2016 demonstrated design stability by releasing over 90 percent of their expected design drawings. This is an encouraging development, as it represents the second year in a row in which all programs being evaluated met this best practice. Out of the other 31 programs that previously held their design reviews, 10 met this best practice and 16 did not. For the 5 remaining programs, the program offices reported this practice was not applicable.

Testing of an early prototype is useful for demonstrating that a system will work as intended and can be built within cost and schedule. Only 1 of the 4 programs—CIRCM—tested a system-level integrated prototype prior to its critical design review. This is a decline since last year's review, when only 2 of the 5 programs we evaluated did not test a system-level prototype before their design review.

One program that did not test a system-level integrated prototype is the VH-92A program, which is developing a helicopter for transporting the President, Vice President, heads of state, and other dignitaries. The program entered system development in 2014 and conducted its design review in July 2016. VH-92A does not have any critical technologies, and it plans to reduce risk by utilizing a commercial aircraft and mature technologies, which are already in use. The program demonstrated some design stability by completing all of its design drawings, but it did not test a system-level integrated prototype. Instead, it plans to verify its design by testing a fully configured, production-level prototype in 2018. Additionally, while both the AMPV and OASuW Inc 1 programs demonstrated some design stability by releasing more than 90 percent of their design drawings, neither tested a system-level prototype before critical design review. The AMPV is a derivative vehicle utilizing mature technologies and sub-systems and the program's acquisition strategy did not allow time to develop and test an early system-level prototype. AMPV plans to test a system-level prototype in the future. OASuW Inc 1 plans to test its system-level prototype in March 2017.

We assessed 31 other programs that held a critical design review prior to 2016, and found that only 5 tested an early integrated prototype before critical design review. We did not assess shipbuilding programs against this knowledge-based acquisition practice as testing

early system-level prototypes in these programs may sometimes be impractical, particularly in instances when these programs are not delivering large quantities. The limited use of this testing before design review among the programs we assessed shows no improvement from our prior assessments. Of all the knowledge-based acquisition practices programs strive to implement throughout the acquisition life cycle, this is the least utilized at this juncture. Without demonstrating at this point that the system can work as intended, the risk that the program will face design changes and schedule delays later in the acquisition cycle increases.

Remaining Critical Design Review Best Practices

Of the 4 programs we assessed only the AMPV plans to implement the last five knowledge-based practices shown in figure 14 to increase confidence in the stability of the product's design and its effect on production. This includes establishing a reliability growth curve, identifying key product characteristics, identifying critical manufacturing processes, conducting producibility assessments, and completing a failure mode and effects analysis. The exceptions come from three programs that are not implementing one or more of these practices and instead report the practices are not applicable for various reasons, which include limited production quantities and lack of identified critical technologies. For the other 31 programs in this assessment that have already held their critical design review, a majority of them reported using each of these practices.

3. **Of the three programs that held a production decision during our assessment period, none met all of the best practices. Two programs did not test a production-representative prototype before making a production decision, and only one program demonstrated processes on a pilot production line. The implementation of best practices at this juncture was mixed or slightly degraded compared to DOD programs' past implementation.** Capturing critical manufacturing knowledge before entering production ensures that a weapon system will work as intended and can be manufactured efficiently to meet cost, schedule, and quality targets. This knowledge can be captured through the use of various proactive methods, including the use of statistical process control data, pilot production lines, manufacturing readiness levels, and prototype testing. There are three programs that held a production decision during our assessment period-the F-22 Increment 3.2B Modernization (F-22 Inc 3.2B), the KC-46A Tanker

Modernization (KC-46A), and the Offensive Anti-Surface Warfare Increment 1 (OASuW Inc 1). Figure 15 shows the extent to which these programs have implemented the associated knowledge-based practices.

Figure 15: Implementation of Knowledge-Based Practices for Selected Programs at Production Decision

Knowledge-based practices at production start	F-22 Inc 3.2 B	KC-46A	OASuW Inc 1	For the 15 non-shipbuilding programs that have reached this juncture[b] ●	○	––
Demonstrate all critical technologies in an operational environment	●	●	●	9	3	3
Release at least 90 percent of drawings	●	●	●	7	4	4
Demonstrate manufacturing process capabilities are in control	○	○	○	1	11	3
Demonstrate critical processes on a pilot production line	○	●	––	8	4	3
Test a production-representative prototype in its intended environment	○	●	○	6	7	2

● Practice implemented

○ Practice not implemented

––– Practice not applicable or information not available per the program office response

F-22 Inc 3.2B = F-22 Increment 3.2B Modernization
KC-46A = KC-46A Tanker Modernization Program
OASuW Inc 1 = Offensive Anti-Surface Warfare Increment 1

Source: GAO analysis of Department of Defense data. | GAO-17-333SP

[b]We have excluded shipbuilding programs from this analysis due to differences in the production processes used to construct ships.

Demonstrate Manufacturing Process Capabilities Are in Control

None of the programs that held recent production decisions demonstrated that their manufacturing process capabilities were in control. Our prior work has shown that capturing critical manufacturing knowledge before entering production helps ensure that the system will work as intended and will meet cost, schedule, and quality targets. Of the remaining 15 non-shipbuilding programs we assessed, which held production decisions before our current assessment period, one

provided data indicating that critical manufacturing processes were in control at the time of their production start. Of all the knowledge-based acquisition practices described, this is the least utilized at this juncture.

Demonstrate Critical Processes on a Pilot Production Line

One of the programs that held a production decision over the past year demonstrated critical processes on a pilot production line. This is a fair decline from what we observed last year, when all 5 of the programs we reviewed met this knowledge practice. Of the 21 programs we assessed that plan to hold a production decision in the future, 11 indicated that they intended to test a pilot production line before production start. Of the remaining 15 non-shipbuilding programs, 8 have demonstrated this best practice whereas 4 did not.

Test a Production-representative Prototype in Its Intended Environment

Our body of work has shown that production and post-production costs are also minimized when a fully integrated, production-representative prototype is demonstrated prior to the production decision, as making design changes after production begins can be both costly and inefficient. The KC-46A plans to meet this best practice, but the F-22 Inc 3.2B and OASuW Inc 1 do not plan to complete this testing until approximately 4 months and 1 year, respectively, after their production decision dates. Additionally, 16 of the programs we assessed that plan to hold their production decision in the future intend to test a fully configured prototype. Programs that do not conduct testing of production-representative prototypes prior to beginning manufacturing risk discovering deficiencies late in testing, which may trigger the need for expensive re-tooling of production lines and retrofitting of articles that have completed production. Of the other 15 non-shipbuilding programs we assessed, 6 reported testing a production-representative prototype before this decision.

4. **Eighteen programs in production plan to complete 30 percent or more of their developmental testing concurrent with production. Nine of these 18 programs plan to place 20 percent or more of their procurement quantities under contract before testing is complete.** Conducting developmental testing while in production increases the risk of finding problems that could lead to design

changes and costly retrofits. Developmental testing is intended to demonstrate that a chosen design has the capabilities required and to discover and fix problems before a system enters production. Though DOD policy allows some degree of concurrency between initial production and developmental testing, beginning production before demonstrating that a system will work as intended increases the risk of deficiencies that require substantial design changes and costly modifications to already-produced systems.

Eighteen of the programs we assessed plan to complete a significant portion of their testing—30 percent or more—after they have already started production. Further, 9 of these programs also plan to put 20 percent or more of their procurement quantities under contract before the testing in complete. These programs are the DDG 1000 Zumwalt Class Destroyer, F-22 Increment 3.2B Modernization, Global Positioning System III, LHA 6 America Class Amphibious Assault Ship, M109A7 Family of Vehicles, MQ-8 Fire Scout Unmanned Aircraft System, Offensive Anti-Surface Warfare Increment 1, F-35 Lightning II, and the Family of Advanced Beyond Line-of-Sight Terminals. Concurrency is also justified to expedite the development of an accelerated acquisition program. However, concurrently developing and producing high cost systems without knowing whether their capabilities can be demonstrated is a high-risk strategy.

5. **Of the 54 current and future programs we assessed, 41 reported software development as a high-risk area. Despite this, almost half of the current programs do not separately price or track the cost of the software development efforts. Of the 45 current programs we assessed 11 plan to start production prior to completing software development.** Software development has similar phases to that of hardware and—in the case of new systems—occurs in parallel with hardware development until software and hardware components are integrated. According to DOD policy, major contracts and subcontracts for contractors developing or producing software elements for major defense acquisition programs are required to submit a report, which includes software resources if the effort is projected to be greater than $20 million.[34] Half of the

[34]Specifically, all major contracts and subcontracts, regardless of contract type, for contractors developing or producing software elements within MDAP and pre-MDAP programs, as well as other certain acquisitions, such as those of certain automated information systems, for any software development element with a projected software effort greater than $20 million (then-year dollars) are required to complete a Software Resources Data Report. DOD Instruction 5000.02.

programs we assessed do not track the cost of their software development, citing a variety of reasons. For example, several programs reported that the software is embedded into the overall system development and would be difficult to extract.

Nonetheless, of the 45 current programs we surveyed, 35 indicated that they had identified software development as a high-risk area, similar to the number of programs that reported this in 2016. Of the 9 future programs, 6 identified their software development as high risk.

Programs report a variety of reasons that lead to characterizing their software development effort as high risk. Common reasons include:

- Completion of the originally planned software effort has proved to be more difficult than expected (27 programs),
- Completion of the software effort needed to conduct developmental testing successfully (30 programs),
- Changes to meet cyber security needs led to additional software development efforts (25 programs), and
- Completion of the software effort to conduct operational testing successfully (21 programs).

Of the 35 programs identifying software development as high risk, 26 percent are not tracking their software costs. Programs not tracking software costs limit the information managers and decision makers have, making it difficult to manage and oversee these programs. DOD Instruction 5000.02 provides programs several types of acquisition models from which to choose. Two of the 54 programs in our assessment reported using the defense unique software intensive program model, and 3 identified themselves as “hybrid program—software dominant.” A majority of programs estimated that between 0 to 20 percent of their total acquisition cost is for software.

Eleven of the 45 current programs we assessed plan to begin production prior to completing the software development necessary for integration with system hardware and achieving baseline capabilities. DOD policy allows for some degree of concurrency between initial production and the completion of developmental testing, especially for the completion of software. While some concurrency may be necessary when rapidly fielding urgently needed capabilities, pursuing software development while the system is in production may introduce risks if problems are discovered late in testing.

Assessments of Individual Programs

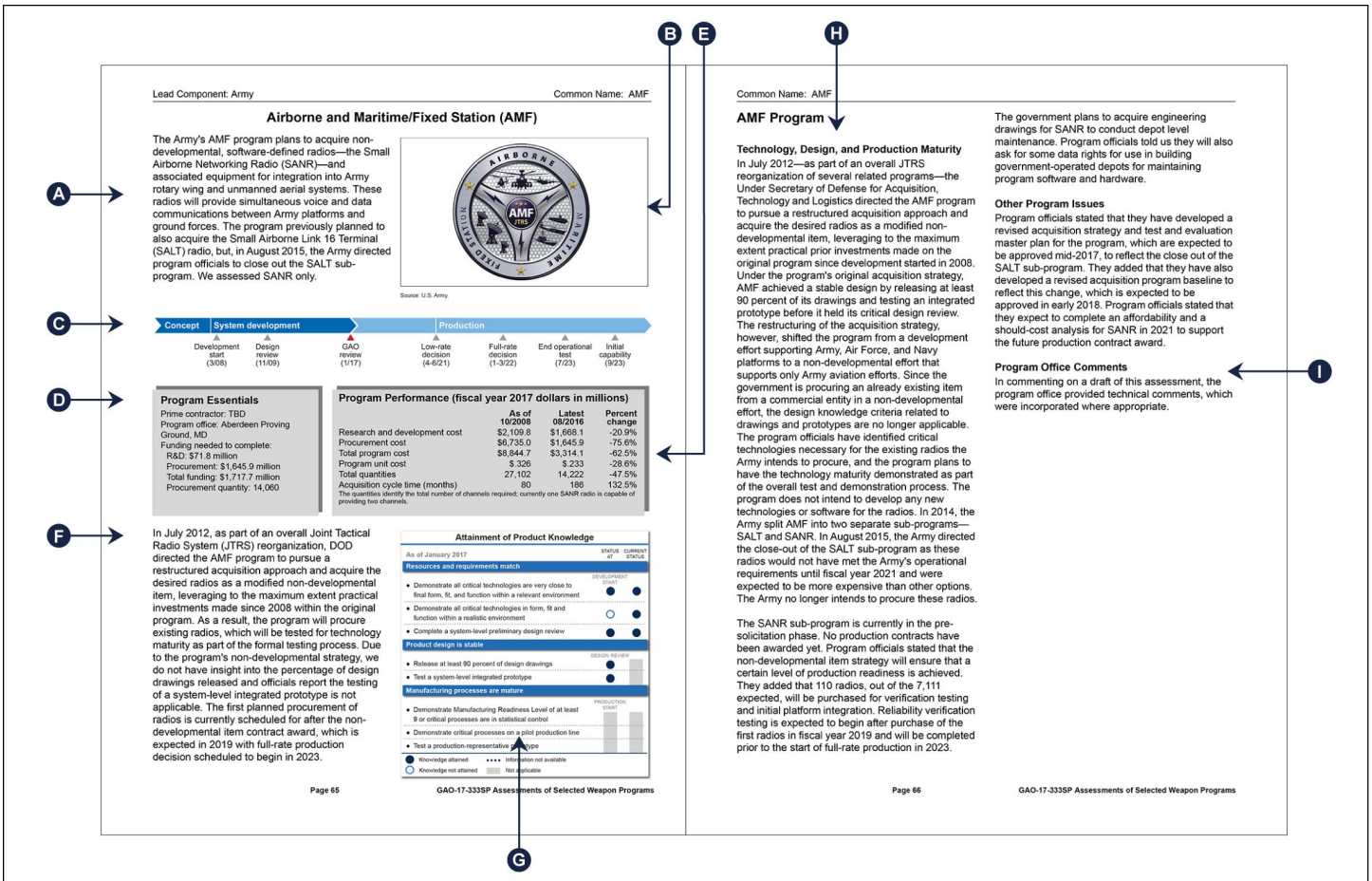
This section contains assessments of individual weapon programs grouped by lead service—Army, Navy and Marine Corps, Air Force, and DOD-led—and includes a lead service separator page at the start of each grouping. Each assessment presents data on the extent to which programs are following a knowledge-based acquisition approach to product development, and other program information. Each lead service separator page summarizes information about the acquisition phase, current estimated funding needs, cost and schedule growth, and product knowledge attained. In total, we present information on 54 programs.[35]

For 43 programs, we produced two-page assessments discussing the technology, design, and manufacturing knowledge obtained, as well as other program issues. Each two-page assessment also contains a comparison of total acquisition cost from the first full estimate for the program to the current estimate. The first full estimate is generally the cost estimate established at development start; however, for a few programs that did not have such an estimate, we used the estimate at production start instead. For shipbuilding programs, we used their planning estimates if those estimates were available. For programs that began as non-major defense acquisition programs, we used the first full estimate available. All of these 43 two-page assessments are of major defense acquisition programs, most of which are in development or early production and 3 assessments are of programs that were projected to become major defense acquisition programs during or soon after our review. See figure 16 for an illustration of the layout of each two-page assessment.

In addition, we produced one-page assessments on the current status of 11 programs, which include 9 future major defense acquisition programs and 2 major defense acquisition programs that are well into production, but are developing new increments of capability as part of their existing programs. We also produced a one-page assessment of the Navy's Frigate initiative, which DOD has not yet formally identified as a future major defense acquisition program.

[35]In addition to the 54 program assessments, we separately assessed the Navy's Frigate initiative, which is currently part of the Navy's Littoral Combat Ship program.

Figure 16: Illustration of Program Two-Page Assessment



- **A** Program description
- **B** Illustration or photo of system
- **C** Schedule timeline identifying key dates for the program including the start of development, major design reviews, production decisions, and planned operational capability
- **D** **Program Essentials** Programmatic information including the prime contractor, program office location, and funding needed to complete
- **E** **Program Performance** Cost and schedule baseline estimates and the latest estimate provided as of January 2017
- **F** Brief summary describing the program's implementation of knowledge-based acquisition practices and its current status
- **G** **Attainment of Product Knowledge** Depiction of selected knowledge-based practices and the program's progress in attaining that knowledge
- **H** Assessment of program's technology, design, and production maturity, as well as other program issues
- **I** **Program Office Comments** General comments provided by the cognizant program office

Source: GAO analysis. | GAO-17-333SP

For our two-page assessments, we depict the extent of knowledge gained in a program at the time of our review with a scorecard and narrative summary at the bottom of the first page of each assessment. These scorecards display key knowledge-based acquisition practices that should

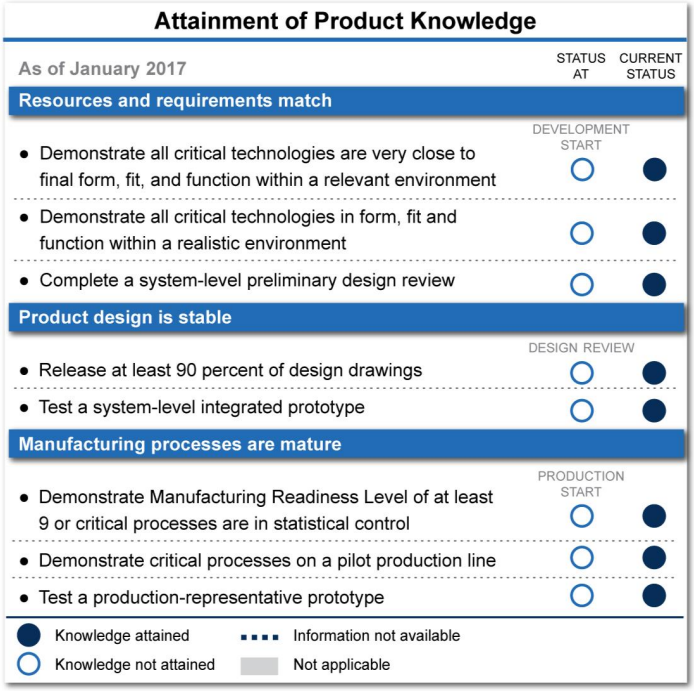
be implemented by certain points in the acquisition process. The more knowledge the program has attained by each of these key points, the more likely the weapon system will be delivered within its estimated cost and schedule. A knowledge deficit means the program is proceeding without sufficient knowledge about its technologies, design, or manufacturing processes, and faces unresolved risks that could lead to cost increases and schedule delays.

For each program, we identify a knowledge-based practice that has been implemented with a closed circle. We identify a knowledge-based practice that has not yet been implemented with an open circle. If the program did not provide us with enough information to make a determination, we show this with a dashed line. A knowledge-based practice that is not applicable to the program is grayed out. A knowledge-based practice may not be applicable to a particular program if the point in the acquisition cycle when the practice should be implemented has not yet been reached, or if the particular practice is not relevant to the program. For programs that have not yet entered system development, we show a projection of knowledge attained for the first three practices. For programs that have entered system development but not yet held a critical design review, we assess actual knowledge attained for these three practices. For programs that have held a critical design review but not yet entered production, we assess knowledge attained for the first five practices. For programs that have entered production, we assess knowledge attained for all eight practices.

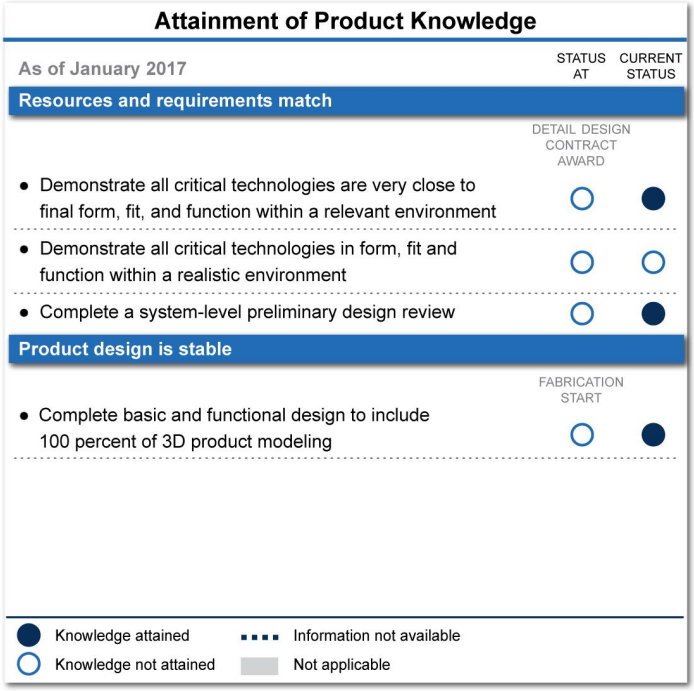
We make adjustments to both the key points in the acquisition cycle and the applicable knowledge-based practices for shipbuilding programs. For shipbuilding programs that have not yet awarded a detail design contract, we show a projection of knowledge attained for the first three practices. For shipbuilding programs that have awarded this contract but not yet started construction, we would assess actual knowledge attained for these three practices. For shipbuilding programs that have started construction, we assess the knowledge attained for the first four practices. We do not assess the remaining four practices for shipbuilding programs as they are not applicable for these programs. See figure 17 for examples of the knowledge scorecards we use to assess these different types of programs.

Figure 17: Examples of Knowledge Scorecards

Program in production



Shipbuilding program



Source: GAO. | GAO-17-333SP

Statement on Small Business Participation

Pursuant to a mandate in a report for the National Defense Authorization Act for Fiscal Year 2013, we reviewed whether individual subcontracting reports from a program's prime contractor or contractors were acknowledged—reviewed by the agency that awarded the contract and found to have no errors or other issues—on the Electronic Subcontracting Reporting System (eSRS).[36] Federal law requires prime contractors to make a good faith effort to award a portion of their subcontracts to small businesses and in some cases to have small business subcontracting

[36]H.R. Rep. No. 112-479, at 284 (2012).

plans.[37] We reviewed this information for 78 of the major defense acquisition programs in our assessment that reported contract information in their December 2015 Selected Acquisition Report (SAR) submissions. The contract numbers for each program's prime contracts were entered into the eSRS database to determine whether the individual subcontracting reports from the prime contractors had been acknowledged by the government. The government uses individual subcontracting reports on eSRS as one method of monitoring small business participation, as the report includes goals for small business subcontracting. Not all prime contracts for major defense acquisition programs are required to submit individual subcontracting reports. For example, some contractors report small business participation at a corporate level as opposed to a program level and these data are not captured in the individual subcontracting reports. Information gathered for this analysis is presented in appendix VI.

[37]Small business subcontracting plans, which are required by the Small Business Act, 15 U.S.C. § 637(d), establish goals for small business subcontracting and describe how the contractor plans to achieve those goals.

Program Assessments (see atttached PDF)

Agency Comments

We provided a draft of this report to DOD for comment. In its comments, reproduced in appendix VII, DOD generally concurred with our observations. DOD also provided us with technical comments, which we incorporated as appropriate.

In its comments, DOD noted that our report identifies many ways in which the department continues to drive down the cost of the acquisition portfolio. Further, DOD stated that our observations appear to validate its focus on continuous improvement on cost, schedule, and performance measures of programs using the “Better Buying Power” and other initiatives. The department also identified plans to publish its own comprehensive report on the acquisition system in the summer of 2017, as it has done in previous years.
We are sending copies of this report to interested congressional committees and offices; the Secretary of Defense; the Secretaries of the Army, Navy, and Air Force; and the Director of the Office of Management and Budget. In addition, the report will be made available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions concerning this report, please contact me at (202) 512-4841. Contact points for our offices of Congressional Relations and Public Affairs may be found on the last page of this report. Staff members making key contributions to this report are listed in appendix VIII.

Michael J. Sullivan
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 J. 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: Scope and Methodology

Analysis of the Cost Performance of DOD's Portfolio of Major Defense Acquisition Programs

To develop our 11 observations on the cost and schedule of the Department of Defense portfolio of current major defense acquisition programs, we obtained and analyzed cost, quantity, and schedule data from Selected Acquisition Reports (SAR) and other information in the Defense Acquisition Management Information Retrieval Purview system, referred to as DAMIR.[1] We entered this data into a database and verified that the data were entered correctly. We converted all cost information to fiscal year 2017 dollars using conversion factors from the DOD Comptroller's National Defense Budget Estimates for Fiscal Year 2017 (table 5-9). To assess the reliability of the SAR data, we reviewed our previous assessment and DOD officials' responses regarding any changes to DAMIR's data quality control procedures. We determined that the SAR data and the information retrieved from DAMIR were sufficiently reliable for the purposes of this report. Our assessment includes comparisons of cost and schedule changes over the past year, 5 years, and from baseline estimates that utilize SAR data from December 2015, December 2014, December 2010, and from the programs' initial SAR submissions. We also analyzed the data to determine the number of programs in each portfolio year. In general, we refer to the 78 major defense acquisition programs with SARs dated December 2015 as DOD's 2016 or current portfolio and use a similar convention for prior year portfolios. We retrieved data on research, development, test, and evaluation; procurement; military construction, acquisition operation and maintenance, and total acquisition costs, as well as schedule estimates for the 78 programs in the 2016 portfolio.[2]

We divided 2 programs into two distinct elements, because DOD reports performance data on them separately. As a result some of our analysis

[1]DAMIR Purview is an executive information system operated by the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics Acquisition Resources and Analysis.

[2] We refer to research, development, test, and evaluation costs as research and development or simply as development costs in this report. Total acquisition cost includes research and development and procurement costs as well as acquisition related operation and maintenance and system-specific military construction costs.

reflects a total of 80 programs and sub-elements. The Missile Defense Agency's Ballistic Missile Defense System and its elements are excluded from all analyses as they do not have an integrated long-term baseline, which prevents us from assessing the program's cost progress or comparing it to other major defense acquisition programs.

For our first observation, we compared the 2016 portfolio with the programs that issued SARs in December 2014 (2015 portfolio) to identify the programs that exited and entered the current portfolio and the total cost and schedule change in the current portfolio over the past year.

We then divided the programs into percent cost change categories based on the percent change in total acquisition cost they experienced over the past year. We then totaled the number of programs in each category and the total cost change of the programs in each category.

For the second observation, we identified the development and procurement funding and the change in these over the past year. We identified the specific programs with the largest development and procurement cost increases and whether those were due to quantity changes.

For the third observation, we aggregated funding stream data for the total planned investment of each portfolio from DAMIR for each year since 2006 to determine any trends. We determined the yearly totals for research and development, procurement, and total acquisition cost. To distinguish the funding already invested from the funding remaining that is needed to complete the programs in each portfolio since 2006, we used funding stream data obtained from DAMIR for each December SAR submission for the years 2005 (2006 portfolio) through 2015 (2016 portfolio). We define funding invested as all funding that has been provided to the programs in the fiscal year of the annual SAR submission (this includes fiscal year 2016 for the December 2015 submission) and earlier, while funding remaining is all the amounts that will be provided in the fiscal years after the annual SAR submission (fiscal year 2017 and later for the December 2015 submission).

For our fourth observation, we determined the cost and schedule changes on defense acquisition programs in the current portfolio over the past 5 years and from baseline estimates. To do this, we collected data from December 2015, December 2010, and from programs' initial SARs; acquisition program baselines; and program offices. In addition, we

analyzed programs' cost growth after three key decision points: development start, critical design review, and production decision.

For programs less than a year old, we calculated the difference between the December 2015 SAR current estimate and the first full estimate in order to identify the cost and schedule change over the past year. For programs less than 5 years old, we took a similar approach when calculating the cost and schedule change over the past 5 years.

For our fifth observation, in order to determine whether programs experienced an increase or decrease in buying power over the past year, we used data on the programs' number of procurement units, procurement cost changes, and average procurement unit costs.

GAO calculated cost change "due" to quantity changes as the change in quantity over the last year multiplied by the average procurement unit cost for the program a year ago. GAO calculated cost change "not due" to quantity changes as the current acquisition quantity times the change in average per unit costs. In practice, changes in quantity will often affect per unit cost—as discussed in this appendix—so this is more precisely described as "Cost change due to change in quantity assuming no change in average procurement unit cost" and "Cost change due to change in average procurement unit cost." If changes in quantity affect per unit cost, those changes will appear in the cost change "not due" to quantity changes.

The resulting dollar amount is considered a change due solely to shifts in the number of units procured and may overestimate the amount of change expected when quantities increase and underestimate the expected change when quantities decrease, as it does not account for other effects of quantity changes on procurement such as gain or loss of learning in production that could result in changes to unit cost over time or the use or absence of economic orders of material. However, these changes are accounted for as part of the change in cost not due to quantities.

For our sixth observation, we evaluated program performance against high-risk criteria discussed by DOD, the Office of Management and Budget, and GAO. We calculated how many programs had less than a 2 percent increase in total acquisition cost over the past year, less than a 10 percent increase over the past 5 years, and less than a 15 percent increase from baseline estimates using data from SARs, initial acquisition program baselines, and program offices. We calculated the percentage of

programs meeting each of these high-risk criteria for the 2012-2016 time frame to identify any changes.

For programs with multiple sub-programs presented in the SARs, we calculated the net effect of the sub-programs to reach an aggregate program result.

For our seventh observation, we determined which programs had a first full estimate—or started system development—after the implementation date of Dec. 4, 2009 for the Weapon Systems Acquisition Reform Act of 2009 (WSARA). We then examined these programs cost and schedule changes over the past year as a group.

For our eighth observation, we determined what percent of the portfolio's total acquisition cost was allocated to these programs.

For the ninth observation, we divided these programs into percent cost change categories based on the percent change in total acquisition cost they experienced over the past year. We then totaled the number of programs in each category and the total cost change of the programs in each category.

For our 10th observation, we identified programs initial operational capability and start and end dates of their operational testing. We determined whether the initial operational capability date was before, during, or after its testing dates. Based on our determination, we summed and analyzed what percent of programs were in each category. For some programs, either one or both of these dates were not available.

For the 11th observation, we used SAR data to determine which 25 programs had the largest total acquisition cost, and the prime contractors associated with these programs. We gathered information from Bloomberg on the equity prices of each of these contractors from about 1980 to 2016 from these equities to the S&P 500® and the Industrials sector, as defined by the Standard and Poor's Global Industry Classification Standard.

Analysis of Acquisition Initiatives

To develop observations on how DOD is implementing acquisition reforms, we reviewed the DOD Instruction 5000.02, the Weapon Systems Acquisition Reform Act of 2009 (WSARA), and the September 19, 2014,

Under Secretary of Defense for Acquisition, Technology and Logistics "Better Buying Power 3.0 Interim Release" as well as earlier related memoranda.[3] We analyzed questionnaire data received from the 45 current and 9 future major defense acquisition programs in our assessment to determine the extent to which acquisition reforms have been implemented. We assessed the P-8A Poseidon Multi-Mission Maritime Aircraft Increment 3 as part of the 9 future major defense acquisition programs not yet in the portfolio. During the course of our review, we learned that DOD no longer plans to manage Increment 3 separately from the existing P-8A program. We will reflect this change in future assessments of the P-8A program. We determined which programs have established affordability constraints and, for current programs, examined the average development cost growth on programs with these constraints compared to those without. We tallied programs that conducted "should-cost" analyses and identified realized and/or future potential savings. We also analyzed whether programs are planning for competition throughout the acquisition life-cycle and their plans to evaluate cybersecurity vulnerabilities by 2019.

Analysis of Selected DOD Programs Using Knowledge-Based Criteria and Program Concurrency

To collect data from current and future major defense acquisition programs—including cost and schedule estimates, technology maturity, and planned implementation of acquisition reforms—we distributed one data collection instrument and two electronic questionnaires, one questionnaire for the 45 current programs and a slightly different questionnaire for the 9 future programs. Both of the questionnaires were web-based so that respondents could respond and submit their answers online. We received responses from all of the programs we assessed from August to October 2016. To ensure the reliability of the data collected through the data collection instrument and our questionnaires, we took a number of steps to reduce measurement error and non-response error.

These steps included: conducting three pretests of the future major defense acquisition program questionnaire and three pretests for the current major defense acquisition program questionnaire prior to distribution to ensure that our questions were clear, unbiased, and

[3]Pub. L. No. 111-23.

consistently interpreted; reviewing responses to identify obvious errors or inconsistencies; cross-referencing information provided in the data collection instrument with the questionnaire; and conducting follow-up to clarify responses when needed. Our pretests covered each branch of the military to better ensure that the questionnaires could be understood by officials within each branch.

Our analysis of how well programs are adhering to a knowledge-based acquisition approach focuses on 45 major defense acquisition programs that are mostly in development or the early stages of production. To assess the knowledge attained by key decision points (system development start or detailed design contract award for shipbuilding programs, critical design review or fabrication start for shipbuilding programs, and production start), we collected data from program offices about their knowledge at each point.[4] In particular, we focused on the 11 programs that crossed these key acquisition points in 2016 or planned to in early 2017 and evaluated their adherence to knowledge-based practices.

We also provide information on how much knowledge is obtained at key decision points by programs which accomplished these previously. We also included observations on the knowledge that 9 future programs expect to obtain before starting development. We did not validate the data provided by the program offices, but reviewed the data and performed various checks to determine that they were reliable enough for our purposes. Where we discovered discrepancies, we clarified the data accordingly.

For programs that have passed a key decision point and have since been restructured, we will continue to assess them against their original cost and schedule estimates at that milestone or decision point, such as development start. We will not reassess a program at milestones that have already been reached if a program is repeating a key decision point or milestone such as milestone B. We will keep our original assessment

[4]Analysis of shipbuilding programs for technology maturity and design maturity differ as shipbuilding programs must meet these metrics at different points in the acquisition cycle according to GAO's methodology for ships (see GAO, *Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding,* GAO-09-322 (Washington, D.C.: May, 13, 2009). As a result best practices for a knowledge based acquisition approach differ for shipbuilding programs. For these reasons, we exclude the six shipbuilding programs in DOD's portfolio from parts of our analysis at each of the three key decision points.

of the program's knowledge attained at the original milestone. However, we will change a future milestone date if that milestone had not yet been reached and assess the program for its implementation of our best practices at that point in time.

The 54 current and future programs included in our assessment were in various stages of the acquisition cycle, and not all of the programs provided information on knowledge obtained at each point. Programs were not included in our assessments at key decision points if relevant data were not available. Our analysis of knowledge attained at each key point includes factors that we have previously identified as being key to a knowledge-based acquisition approach, including holding early systems engineering reviews, testing an integrated prototype prior to the design review, using a reliability growth curve, planning for manufacturing, and testing a production-representative prototype prior to the making a production decision. Additional information on how we collect these data is found in the product knowledge assessment section of this appendix. See also appendix IV for a list of the practices that are associated with a knowledge-based acquisition approach.

To assess program development testing and production concurrency, we identified the programs—among those we included in our assessment—with production start dates. We used the questionnaire responses from those programs to identify the dates for the start and end of developmental testing, compared those dates to the timing of each program's production decision and determined the number of months, if any, of developmental testing done after production start. We then compared the number of overlapping months to the total number of months of developmental testing for each program and calculated the percentage of developmental testing done concurrent with production.

To examine programs' software development efforts, we identified the programs that reported their software as high-risk. We used the questionnaire responses from these programs to assess the reasons why they identified their software effort as high-risk. We identified the dates reported by programs for their software and hardware integration and compared those dates to each program's production start date to assess each programs' degree of software development and production concurrency.

Individual Assessments of Weapon Programs

This report presents individual assessments of 54 current and future weapon programs. In addition, we assessed the Navy's Frigate initiative separate from the Navy's Littoral Combat Ship program, given DOD's plans to restructure the Frigate into a separate program soon. A table listing these assessments is found in appendix VIII.

Of our 55 total assessments, 43 are captured in a two-page format discussing technology, design, and manufacturing knowledge obtained and other program issues. These two-page assessments are of major defense acquisition programs, most of which are in development or early production. The remaining 12 assessments are described in a one-page format that describes their current status. Those one-page assessments include (1) nine future major defense acquisition programs; (2) two major defense acquisition programs that are well into production but planning to introduce new increments of capability—the DDG-51 Flight III and P-8A Increment 3 modification programs; and (3) the Navy's Frigate initiative. For presentation purposes we grouped the individual assessments by lead service—Army, Navy and Marine Corps, Air Force, and DOD-led—and inserted a lead service separator page at the start of each grouping. These four separator pages summarize information about the acquisition phase, current estimated funding needs, cost and schedule growth, and product knowledge attained that is provided in the one and two-page assessments. We report cost and schedule growth in the separator pages in a manner that is consistent with how it is reported and described elsewhere in the report. Estimates of funding needed to complete in the separator pages are based on all amounts that will be provided in fiscal year 2017 and later. For some future major defense acquisition programs, the estimates of funding needed represents only those amounts provided through fiscal year 2021 and are not the full amount needed to complete the acquisition.

Over the past several years, DOD has revised policies governing weapon system acquisitions and changed the terminology used for major acquisition events. To make DOD's acquisition terminology more consistent across our individual program assessments, we standardized the terminology for key program events. For most individual programs in our assessment, "development start" refers to the initiation of an acquisition program as well as the start of engineering and manufacturing development or system development. This generally coincides with DOD's milestone B. A few programs in our assessment have a separate

"program start" date, which begins a pre–system development phase for program definition and risk-reduction activities. This "program start" date generally coincides with DOD's former terminology for milestone I or DOD's current milestone A, which denotes the start of technology maturation and risk reduction. The "production decision" generally refers to the decision to enter the production and deployment phase, typically with low-rate initial production. The "initial capability" refers to the initial operational capability—sometimes called first unit equipped or required asset availability. For shipbuilding programs, the schedule of key program events in relation to acquisition milestones varies for each program. Our work on shipbuilding best practices has identified the detail design contract award and the start of lead ship fabrication as the points in the acquisition process roughly equivalent to development start and design review for other programs.

For each program we assessed in a two-page format, we present cost, schedule, and quantity data at the program's first full estimate, and an estimate from the latest SAR or the program office reflecting 2016 data where they were available. The first full estimate is generally the cost estimate established at milestone B—development start; however, for a few programs that did not have such an estimate, we used the estimate at milestone C—production start—instead. For shipbuilding programs, we used their planning estimates if those estimates were available. For systems for which a first full estimate was not available, we only present the latest available estimate of cost and quantities. For the other programs assessed in a one-page format, we present the latest available estimate of cost and quantity from the program office.

For each program we assessed, all cost information is presented in fiscal year 2017 dollars. We converted cost information to fiscal year 2017 dollars using conversion factors from the DOD Comptroller's National Defense Budget Estimates for Fiscal Year 2017 (table 5-9). We have depicted only the program's main elements of acquisition cost—research and development and procurement. However, the total program cost also includes military construction and acquisition-related operation and maintenance costs. Because of rounding and these additional costs, in some situations, total cost may not match the exact sum of the research and development and procurement costs. The program unit costs are calculated by dividing the total program cost by the total quantities planned. These costs are often referred to as program acquisition unit costs. In some instances, the data were not applicable, and we annotate this by using the term "not applicable (NA)." The quantities listed refer to total quantities, including both procurement and development quantities.

The schedule assessment for each program is based on acquisition cycle time, defined as the number of months between program start and the achievement of initial operational capability or an equivalent fielding date. In some instances the data were not yet available, and we annotate this by using the term “to be determined (TBD)” or “NA.”

The information presented on the “funding needed to complete” is from fiscal year 2017 through completion and, unless otherwise noted, draws on information from SARs or on data from the program office. In some instances, the data were not available, and we annotate this by the term “TBD” or “NA.” The quantities listed refer only to procurement quantities. Satellite programs, in particular, produce a large percentage of their total operational units as development quantities, which are not included in the quantity figure.

The intent of these comparisons is to provide an aggregate, or overall, picture of a program’s history. These assessments represent the sum of the federal government’s actions on a program, not just those of the program manager and the contractor. DOD does a number of detailed analyses of changes that attempt to link specific changes with triggering events or causes. Our analysis does not attempt to make such detailed distinctions.

In this year’s assessment, we also reviewed whether individual subcontracting reports from a program’s prime contractor or contractors were accepted on the Electronic Subcontracting Reporting System (eSRS). We reviewed this information for 78 of the major defense acquisition programs included in our assessment using the contract information reported in their December 2015 Selected Acquisition Reports. See appendix VI for a list of the programs we reviewed.

Product Knowledge Data on Individual Two-Page Assessments

In our past work examining weapon acquisition issues and best practices for product development, we have found that leading commercial firms pursue an acquisition approach that is anchored in knowledge, whereby high levels of product knowledge are demonstrated by critical points in the acquisition process. On the basis of this work, we have identified three key knowledge points during the acquisition cycle—system development start, critical design review, and production start—at which programs need to demonstrate critical levels of knowledge to proceed. To

assess the product development knowledge of each program at these key points, we reviewed data-collection instruments and questionnaires submitted by programs; however, not every program had responses to each element of the data-collection instrument or questionnaire. We also reviewed pertinent program documentation and discussed the information presented on the data-collection instrument and questionnaire with program officials as necessary.

In this year's report we have made a change to our attainment of product knowledge graphic. In addition to assessing programs' current status in achieving the product knowledge criteria, we now also show programs' progress in meeting the knowledge attainment criteria at the time they reached the three key knowledge points during the acquisition cycle—system development start, critical design review, and production start. For programs that have passed a key decision point and have since been restructured, we continue to assess them against their original cost and schedule estimates at that milestone or decision point, such as development start. We have not reassessed a program at milestones that have already been reached if a program is repeating a key decision point or milestone, such as milestone B. We have kept our original assessment of the program's knowledge attained at the original milestone. However, we have changed future milestone dates in instances when the program had not yet reached the affected milestone. In these instances, we assessed the program for its implementation of our best practices at that point in time.

To assess a program's readiness to enter system development, we collected data through the data-collection instrument on critical technologies and early design reviews. To assess technology maturity, we asked program officials to apply a tool, referred to as technology readiness levels (TRL), for our analysis. The National Aeronautics and Space Administration originally developed TRLs, and the Army and Air Force science and technology research organizations use them to determine when technologies are ready to be handed off from science and technology managers to product developers. TRLs are measured on a scale from 1 to 9, beginning with paper studies of a technology's feasibility and culminating with a technology fully integrated into a completed product. See appendix V for TRL definitions. Our best-practices work has shown that a TRL 7—demonstration of a technology in its final form, fit, and function within a realistic environment—is the level of technology maturity that constitutes a low risk for starting a product

development program.[5] For shipbuilding programs, we have recommended that this level of maturity be achieved by the contract award for detail design.[6] In our assessment, the technologies that have reached TRL 7, a prototype demonstrated in an operational environment, are referred to as mature or fully mature. Those technologies that have reached TRL 6, a prototype very close to final form, fit, and function demonstrated within a relevant environment, are referred to as approaching or nearing maturity. Satellite technologies that have achieved TRL 6 are assessed as fully mature due to the difficulty of demonstrating maturity in an operational environment—space. In addition, we asked program officials to provide the date of the system-level preliminary design review. We compared this date to the system development start date.

In most cases, we did not validate the program offices' selection of critical technologies or the determination of the demonstrated level of maturity. We sought to clarify the TRLs in those cases where information existed that raised concerns. If we were to conduct a detailed review, we might adjust the critical technologies assessed, their readiness levels demonstrated, or both. It was not always possible to reconstruct the technological maturity of a weapon system at key decision points after the passage of many years. Where practicable, we compared technology assessments provided by the program office to assessments conducted by officials from the Office of the Assistant Secretary of Defense for Research and Engineering.

To assess design stability, we asked program officials to provide the percentage of design drawings completed or projected for completion by the design review, the production decision, and as of our current assessment in the data-collection instrument. In most cases, we did not verify or validate the percentage of engineering drawings provided by the program office. We clarified the percentage of drawings completed in those cases where information that raised concerns existed. Completed drawings were defined as the number of drawings released or deemed releasable to manufacturing that can be considered the "build to"

[5]GAO, *Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, GAO-01-288 (Washington, D.C.: Mar. 8, 2001); and *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, GAO/NSIAD-99-162 (Washington, D.C.: July 30, 1999).

[6]GAO, *Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding*, GAO-09-322 (Washington, D.C.: May 13, 2009).

drawings. For shipbuilding programs, we asked program officials to provide the percentage of the three-dimensional product model that had been completed by the start of lead ship fabrication, and as of our current assessment. To gain greater insights into design stability, we also asked program officials to provide the date they planned to first integrate and test all key subsystems and components into a system-level integrated prototype. We compared this date to the date of the design review. We did not assess whether shipbuilding programs had completed integrated prototypes.

To assess production maturity, we asked program officials for their Manufacturing Readiness Level (MRL) for process capability and control or to identify the number of critical manufacturing processes and, where available, to quantify the extent of statistical control achieved for those processes as a part of our data-collection instrument. In most cases, we did not verify or validate the information provided by the program office. We clarified the number of critical manufacturing processes and the percentage of statistical process control where information existed that raised concerns. We used a standard called the Process Capability Index, a process-performance measurement that quantifies how closely a process is running to its specification limits. The index can be translated into an expected product defect rate, and we have found it to be a best practice. We also used data provided by the program offices on their MRL for process capability and control, a sub-thread tracked as part of the manufacturing readiness assessment process recommended by DOD, to determine production maturity. We assessed programs as having mature manufacturing processes if they reported an MRL 9 for that sub-thread—meaning, that manufacturing processes are stable, adequately controlled, and capable. To gain further insights into production maturity, we asked program officials whether the program planned to demonstrate critical manufacturing processes on a pilot production line before beginning low-rate production. We also asked programs on what date they planned to begin system-level developmental testing of a fully configured, production-representative prototype in its intended environment. We compared this date to the production start date. We did not assess production maturity for shipbuilding programs.

Although the knowledge points provide excellent indicators of potential risks, by themselves they do not cover all elements of risk that a program encounters during development, such as funding instability. Our detailed reviews on individual systems normally provide a more comprehensive assessment of risk elements.

We conducted this performance audit from April 2016 to March 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 the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Current and First Full Estimates for DOD's 2016 Portfolio of Major Defense Acquisition Programs

Table 6 contains the current and first full total acquisition cost estimates (in fiscal year 2017 dollars) for each program or element in the Department of Defense's (DOD) 2016 major defense acquisition program portfolio. For each program we show the percent change in total acquisition cost from the first full estimate, as well as over the past year and 5 years.

Table 6: Current Cost Estimates and First Full Estimates for DOD's 2016 Portfolio of Major Defense Acquisition Programs (Fiscal year 2017 dollars (in millions))

Program Name	Current total acquisition cost	First Full Estimate total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
Advanced Extremely High Frequency (AEHF) Satellite	$15,046	$6,910	117.7%	0.6%	-1.5%
AGM-88E Advanced Anti-Radiation Guided Missile (AGM-88E AARGM)	2,731	1,736	57.3	18.8	32.4
AH-64E Apache New Build (AH-64E New Build)	2,264	2,570	-11.9	-3.4	-5.8
AH-64E Apache Remanufacture (AH-64E Remanufacture)	14,104	7,855	79.6	-0.3	21.1
AIM-9X Block II Sidewinder (AIM-9X Blk II)	3,821	4,333	-11.8	7.8	-11.8
Air and Missile Defense Radar (AMDR)	5,426	6,064	-10.5	2.6	-10.5
Airborne and Maritime/Fixed Station (AMF)	3,314	8,845	-62.5	-8.7	-62.8
Armored Multi-Purpose Vehicle (AMPV)	11,074	11,049	0.2	0.2	0.2
AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM)	24,687	11,854	108.3	-2.6	-3.5
Airborne Warning and Control System Block 40/45 Upgrade (AWACS Blk 40/45 Upgrade)	2,849	3,029	-5.9	-0.7	-5.9
B-2 Extremely High Frequency SATCOM and Computer Increment 1 (B-2 EHF Inc1)	594	770	-22.8	-0.1	-12.3
B61 Mod 12 Life Extension Program Tailkit Assembly (B61 Mod 12 LEP TKA)	1,281	1,418	-9.6	-8.0	-9.7

Program Name	Current total acquisition cost	First Full Estimate total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
C-130J Hercules Transport Aircraft (C-130J)	17,315	1,029	1582.0	0.4	3.7
C-5 Reliability Enhancement and Re-engining Program (C-5 RERP)	7,636	11,828	-35.5	-0.2	-5.4
Cooperative Engagement Capability (CEC)	6,201	3,193	94.2	6.2	9.8
CH-47F Improved Cargo Helicopter (CH-47F)	16,080	3,492	360.4	-0.8	2.4
CH-53K Heavy Lift Replacement Helicopter (CH-53K)	26,252	17,958	46.2	1.0	7.9
Chemical Demilitarization-Assembled Chemical Weapons Alternatives (Chem Demil-ACWA)	11,226	2,866	291.7	0.3	1.7
Combat Rescue Helicopter (CRH)	8,532	8,427	1.2	0.2	1.2
Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)	37,540	38,587	-2.7	1.9	1.8
DDG 1000 Zumwalt Class Destroyer (DDG 1000)	23,646	37,751	-37.4	1.4	3.9
DDG 51 Arleigh Burke Class Guided Missile Destroyer (DDG 51)	122,689	16,474	644.8	5.4	11.1
E-2D Advanced Hawkeye Aircraft (E-2D AHE)	21,939	16,001	37.1	0.8	14.0
EA-18G Growler Aircraft (EA-18G)	16,756	9,736	72.1	8.3	35.4
Evolved Expendable Launch Vehicle (EELV)	59,638	18,848	216.4	-2.5	61.4
Enhanced Polar System (EPS)	1,438	1,447	-0.6	-0.2	-0.6
Excalibur Precision 155mm Projectiles (Excalibur)	2,045	5,181	-60.5	3.1	4.0
F-22 Increment 3.2B Modernization (F-22 Inc 3.2B Mod)	1,587	1,626	-2.4	0.3	-2.4
F-35 Lightning II Program (F-35)	336,152	231,806	45.0	-2.2	-5.1
Family of Advanced Beyond Line-of-Sight Terminals (FAB-T)	4,519	3,459	30.7	3.8	-7.5
MQ-8 (Fire Scout)	2,935	2,837	3.5	-0.5	3.5
Ground/Air Task Oriented Radar (G/ATOR)	2,818	1,590	77.3	0.4	77.3
Global Broadcast Service (GBS)	1,341	625	114.6	2.7	7.3
Guided Multiple Launch Rocket System/Guided Multiple Launch Rocket Sys Alt Warhead (GMLRS/GMLRS AW)	6,843	1,918	256.8	-1.4	8.3
Global Positioning System III (GPS III)	5,772	4,275	35.0	16.1	22.8
Next Generation Operational Control System (GPS OCX)	4,353	3,592	21.2	15.2	21.2
H-1 Upgrades (4BW/4BN) (H-1 Upgrades)	13,241	3,934	236.6	-0.9	-2.8

Program Name	Current total acquisition cost	First Full Estimate total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
HC/MC-130 Recapitalization Aircraft (HC/MC-130 Recap)	14,343	9,072	58.1	-1.6	1.0
Integrated Air and Missile Defense (IAMD)	6,501	5,454	19.2	0.9	8.4
Intercontinental Ballistic Missile Fuze Modernization (ICBM Fuze Mod)	1,908	1,890	1.0	0.3	1.0
Integrated Defensive Electronic Countermeasures (IDECM) Sum	3,031	2,362	28.4	11.9	17.5
IDECM Block 4	1,195	753	58.7	28.0	34.1
IDECM Blocks 2/3	1,836	1,608	14.2	3.4	8.7
Joint Air-to-Ground Missile (JAGM)	5,854	5,841	0.2	0.2	0.2
Joint Air-to-Surface Standoff Missile (JASSM)	7,486	4,960	50.9	0.8	-8.1
JASSM Baseline	3,363	2,514	33.8	1.5	-18.0
JASSM Extended Range (JASSM-ER)	4,123	2,446	68.6	0.2	1.9
Joint Direct Attack Munition (JDAM)	9,998	3,709	169.6	7.4	40.1
Joint Light Tactical Vehicle (JLTV)	20,467	24,445	-16.3	-15.5	-16.3
Joint Precision Approach and Landing System Increment 1A (JPALS Inc 1A)	1,965	1,098	79.0	22.2	84.3
Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios (JTRS HMS)	9,564	10,888	-12.2	3.6	63.8
KC-130J Transport Aircraft (KC-130J)	9,675	10,288	-6.0	-1.7	-5.0
KC-46A Tanker Modernization Program (KC-46A)	43,627	47,535	-8.2	-0.9	-8.2
Littoral Combat Ship (LCS)	26,650	2,434	994.8	25.8	-25.3
Littoral Combat Ship - Mission Modules (LCS Packages)	7,101	7,108	-0.1	1.4	-0.1
LHA 6 America Class Amphibious Assault Ship (LHA 6)	9,989	3,449	189.6	-0.9	-8.8
LPD 17 San Antonio Class Amphibious Transport Dock (LPD 17)	21,502	12,705	69.2	-0.1	6.1
M109A7 Family of Vehicles (M109A7 FOV)	7,405	7,254	2.1	1.7	2.1
MH-60R Multi-Mission Helicopter (MH-60R)	14,670	6,004	144.3	-0.4	-8.0
Multifunctional Information Distribution System (MIDS)	5,019	1,414	254.8	21.1	53.0
MQ-1C Gray Eagle Unmanned Aircraft System (MQ-1C Gray Eagle)	5,377	1,101	388.2	1.3	-3.9

Program Name	Current total acquisition cost	First Full Estimate total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
MQ-4C Triton Unmanned Aircraft System (MQ-4C Triton)	13,123	13,936	-5.8	1.3	-7.3
MQ-9 Reaper Unmanned Aircraft System (MQ-9 Reaper)	12,018	2,860	320.2	-2.2	-6.8
Mobile User Objective System (MUOS)	7,403	7,291	1.5	-5.1	-2.2
Navy Multiband Terminal (NMT)	2,314	2,518	-8.1	7.3	13.4
P-8A Poseidon Multi-Mission Maritime Aircraft (P-8A)	33,477	33,665	-0.6	-0.5	-6.4
Patriot Advanced Capability-3 Missile Segment Enhancement (PAC-3 MSE)	6,538	7,905	-17.3	1.8	-24.1
Remote Minehunting System (RMS)	886	1,564	-43.3	-44.3	-42.2
Space Based Infrared System High (SBIRS High)	19,184	4,986	284.7	-0.8	-3.6
Small Diameter Bomb Increment II (SDB II)	4,296	5,100	-15.8	7.0	-15.7
Standard Missile-6 (SM-6)	9,195	6,183	48.7	1.5	34.6
Space Fence Ground-Based Radar System Increment 1	1,553	1,632	-4.8	-3.2	-4.8
Ship to Shore Connector Amphibious Craft (SSC)	4,000	4,288	-6.7	-3.2	-6.7
SSN 774 Virginia Class Submarine (SSN 774)	95,599	65,574	45.8	3.7	5.2
Tactical Tomahawk RGM-109E/UGM 109E Missile (TACTOM)	6,987	2,295	204.4	10.5	-7.2
Trident II (D-5) Sea-Launched Ballistic Missile UGM 133A (Trident II Missile)	58,527	51,207	14.3	0.2	1.4
UH-60M Black Hawk Helicopter (UH-60M Black Hawk)	26,488	14,069	88.3	-0.3	-3.0
V-22 Osprey Joint Services Advanced Vertical Lift Aircraft (V-22)	63,534	43,501	46.1	1.5	2.4
VH-92A Presidential Helicopter Replacement Program	4,819	4,842	-0.5	-1.1	-0.5
Wideband Global SATCOM (WGS)	4,269	1,295	229.7	2.8	7.1
Warfighter Information Network-Tactical Increment 2 (WIN-T Inc 2)	10,680	4,022	165.5	1.3	62.7
Warfighter Information Network-Tactical Increment 3 (WIN-T Inc 3)	2,038	17,754	-88.5	-0.4	-86.5

Source: GAO analysis of DOD data. | GAO-17-333SP

Notes: Data were obtained from DOD's Selected Acquisition Reports, acquisition program baselines, and, in some cases, program offices.

Appendix III: Changes in DOD's 2016 Portfolio of Major Defense Acquisition Programs over 5 Years and Since First Full Estimates

Table 7 shows the change in research and development cost, procurement cost, total acquisition cost, and average delay in delivering initial operational capability for those programs in the Department of Defense's (DOD) 2016 portfolio over the last 5 years and since their first full cost and schedule estimates.

Table 7: Cost and Schedule Changes for Programs in DOD's 2016 Portfolio (Fiscal year 2017 dollars (in billions))

	5 year comparison (2011-2016)	Since first full estimate (baseline to 2016)
Change in total research and development cost	12.2	100.5
	4.4%	53.2%
Change in total procurement cost	-5.5	381.5
	-0.5%	48.9%
Change in total other acquisition costs[a]	1.9	2.3
	16.5%	21.3%
Change in total acquisition cost	8.6	484.3
	0.6%	49.4%
Average delay in delivering initial capabilities	11.0 months	30.8 months
	13.4%	40.0%

Source: GAO analysis of DOD data. | GAO-17-333SP

Notes: Data were obtained from DOD's Selected Acquisition Reports and acquisition program baselines. In a few cases data were obtained directly from program offices. Some numbers may not sum due to rounding.

[a]Other total acquisition costs include acquisition-related operation and maintenance and system-specific military construction costs.

Appendix IV: Knowledge-Based Acquisition Practices

GAO's prior work on best product-development practices found that successful programs take steps to gather knowledge that confirm that their technologies are mature, their designs stable, and their production processes are in control. Successful product developers ensure a high level of knowledge is achieved at key junctures in development. We characterize these junctures as knowledge points. The Related GAO Products section of this report includes references to the body of work that helped us identify these practices and apply them as criteria in weapon system reviews. The following table summarizes these knowledge points and associated key practices.

Table 8: Best Practices for Knowledge-based Acquisitions

Knowledge Point 1: Technologies, time, funding, and other resources match customer needs. Decision to invest in product development
Demonstrate technologies to a high readiness level—Technology Readiness Level 7—to ensure technologies will work in an operational environment [a]
Ensure that requirements for product increment are informed by preliminary design review using systems engineering process (such as prototyping of preliminary design)
Establish cost and schedule estimates for product on the basis of knowledge from preliminary design using systems engineering tools (such as prototyping of preliminary design)
Constrain development phase (5 to 6 years or less) for incremental development
Ensure development phase fully funded (programmed in anticipation of milestone)
Align program manager tenure to complete development phase
Contract strategy that separates system integration and system demonstration activities
Conduct independent cost estimate
Conduct independent program assessment
Conduct major milestone decision review for development start

Knowledge Point 2: Design is stable and performs as expected. Decision to start building and testing production-representative prototypes
Complete system critical design review
Complete 90 percent of engineering design drawing packages
Complete subsystem and system design reviews
Demonstrate with system-level integrated prototype that design meets requirements
Complete the failure modes and effects analysis
Identify key system characteristics
Identify critical manufacturing processes
Establish reliability targets and growth plan on the basis of demonstrated reliability rates of components and subsystems
Conduct independent cost estimate
Conduct independent program assessment
Conduct major milestone decision review to enter system demonstration

Knowledge Point 3: Production meets cost, schedule, and quality targets. Decision to produce first units for customer
Demonstrate manufacturing processes
Build and test production-representative prototypes to demonstrate product in intended environment
Test production-representative prototypes to achieve reliability goal
Collect statistical process control data
Demonstrate that critical processes are capable and in statistical control
Conduct independent cost estimate
Conduct independent program assessment
Conduct major milestone decision review to begin production

Source: GAO. | GAO-17-333SP

[a]DOD considers Technology Readiness Level 6, demonstrations in a relevant environment, to be appropriate for programs entering system development; therefore we have analyzed programs against this measure as well.

Appendix V: Technology Readiness Levels

Table 9: Technology Readiness Levels and Descriptions

Number	Technology readiness level	Description	Hardware/software	Demonstration environment
1.	Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties	None (paper studies and analysis)	None
2.	Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. The application is speculative and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies.	None (paper studies and analysis)	None
3.	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.	Analytical studies and demonstration of non-scale individual components (pieces of subsystem)	Lab
4.	Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in a laboratory.	Low-fidelity breadboard. Integration of non-scale components to show pieces will work together. Not fully functional or form or fit but representative of technically feasible approach suitable for flight articles.	Lab
5.	Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.	High-fidelity breadboard. Functionally equivalent but not necessarily form and/or fit (size weight, materials, etc.). Should be approaching appropriate scale. May include integration of several components with reasonably realistic support elements/subsystems to demonstrate functionality.	Lab demonstrating functionality but not form and fit. May include flight demonstrating breadboard in surrogate aircraft. Technology ready for detailed design studies.

Number	Technology readiness level	Description	Hardware/software	Demonstration environment
6.	System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in simulated realistic environment.	Prototype. Should be very close to form, fit and function. Probably includes the integration of many new components and realistic supporting elements/subsystems if needed to demonstrate full functionality of the subsystem.	High-fidelity lab demonstration or limited/restricted flight demonstration for a relevant environment. Integration of technology is well defined.
7.	System prototype demonstration in an operational environment	Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in a realistic environment, such as in an aircraft, vehicle or space. Examples include testing the prototype in a test bed aircraft.	Prototype. Should be form, fit and function integrated with other key supporting elements/subsystems to demonstrate full functionality of subsystem.	Flight demonstration in representative realistic environment such as flying test bed or demonstrator aircraft. Technology is well substantiated with test data.
8.	Actual system completed and "flight qualified" through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.	Flight-qualified hardware	Developmental Test and Evaluation in the actual system application.
9.	Actual system "flight proven" through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of true system development. Examples include using the system under operational mission conditions.	Actual system in final form	Operational Test and Evaluation in operational mission conditions.

Source: GAO and its analysis of National Aeronautics and Space Administration data. | GAO-17-333SP

Appendix VI: Major Defense Acquisition Programs' Individual Subcontracting Reports in the Electronic Subcontracting Reporting System

Table 10 shows the number of prime contractors for the programs we assessed where an individual subcontracting report is reported as acknowledged during 2016 in the Electronic Subcontracting Reporting System (eSRS). We reviewed this information for 78 major defense acquisition programs included in our assessment that reported prime contract information in their December 2015 Selected Acquisition Report (SAR) submissions. The government uses individual subcontracting reports from eSRS as one method of monitoring small business participation, as this tool includes information on contractors' performance against small business subcontracting goals. There are multiple reasons why a prime contractor may not have an acknowledged subcontracting report in eSRS. For example, some contractors may have pending or rejected reports within the system, as all reports are reviewed prior to acknowledgment. Not all prime contracts for major defense acquisition programs are required to submit individual subcontracting reports. For example, some contractors report small business participation at a corporate level as opposed to the program level, and this data is not captured in the individual subcontracting reports.[1] In addition, although a

[1]As of December 2016, 10 major defense companies were participating in the Test Program for Negotiation of Comprehensive Small Business Subcontracting Plans created by the National Defense Authorization Act for Fiscal Years 1990 and 1991 Pub. L. No. 101-189, § 834 (1989). These major defense companies have each established a comprehensive subcontracting plan on a corporate, division or plant-wide basis under which a single summary subcontract report is submitted semi-annually for any covered DOD contracts. The test program has been extended by Congress several times with the current three year extension made by the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015, Pub. L. No. 113-291 § 821 (2014) to end on December 31, 2017. Participation in the test program is on a voluntary basis such that these major defense companies may have contracts where they are reporting on an individual basis as well as contracts where they are reporting on a comprehensive basis.

prime contractor may be required to submit a report, it may not yet have done so for the period we reviewed.[2]

Table 10: Major Defense Acquisition Programs' Individual Subcontracting Reports in the Electronic Subcontracting Reporting System

Program name	Number of contracts listed in the December 2015 SAR	Contracts with an accepted individual subcontracting report (as of October 2016)
Advanced Extremely High Frequency (AEHF) Satellite	2	0
AGM-88E Advanced Anti-Radiation Guided Missile (AGM-88E AARGM)	3	2
AH-64E Apache New Build (AH-64E New Build)	1	1
AH-64E Apache Remanufacture (AH-64E Remanufacture)	6	3
AIM-9X Block II Sidewinder (AIM-9X Blk II)	6	0
Air and Missile Defense Radar (AMDR)	1	0
Airborne and Maritime/Fixed Station (AMF)	0	0
Armored Multi-Purpose Vehicle (AMPV)	1	1
AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM)	5	0
Airborne Warning and Control System Block 40/45 Upgrade (AWACS Blk 40/45 Upgrade)	1	0
B-2 Extremely High Frequency SATCOM and Computer Increment 1 (B-2 EHF Inc1)	1	1
B61 Mod 12 Life Extension Program Tailkit Assembly (B61 Mod 12 LEP TKA)	1	1
C-130J Hercules Transport Aircraft (C-130J)	9	1
C-5 Reliability Enhancement and Re-engining Program (C-5 RERP)	1	0
Cooperative Engagement Capability (CEC)	5	0
CH-47F Improved Cargo Helicopter (CH-47F)	1	0
CH-53K Heavy Lift Replacement Helicopter (CH-53K)	2	0
Chemical Demilitarization-Assembled Chemical Weapons Alternatives (Chem Demil-ACWA)	2	0
Combat Rescue Helicopter (CRH)	1	0
Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)	4	3
DDG 1000 Zumwalt Class Destroyer (DDG 1000)	2	2
DDG 51 Arleigh Burke Class Guided Missile Destroyer (DDG 51)	5	5
E-2D Advanced Hawkeye Aircraft (E-2D AHE)	6	4

[2]For further information on the limitations of eSRS and other contract reporting systems, see GAO, *Federal Subcontracting: Linking Small Business Subcontractors to Prime Contracts Is Not Feasible Using Current Systems*, GAO-15-116 (Washington, D.C.: Dec. 11, 2014).

Program name	Number of contracts listed in the December 2015 SAR	Contracts with an accepted individual subcontracting report (as of October 2016)
EA-18G Growler Aircraft (EA-18G)	6	3
Evolved Expendable Launch Vehicle (EELV)	4	2
Enhanced Polar System (EPS)	1	1
Excalibur Precision 155mm Projectiles (Excalibur)	0	0
F-22 Increment 3.2B Modernization (F-22 Inc 3.2B Mod)	1	0
F-35 Lightning II Program (F-35)	6	0
Family of Advanced Beyond Line-of-Sight Terminals (FAB-T)	2	0
Ground/Air Task Oriented Radar (G/ATOR)	2	0
Global Broadcast Service (GBS)	1	0
Guided Multiple Launch Rocket System/Guided Multiple Launch Rocket Sys Alt Warhead (GMLRS/GMLRS AW)	5	0
Global Positioning System III (GPS III)	2	0
H-1 Upgrades (4BW/4BN) (H-1 Upgrades)	4	3
HC/MC-130 Recapitalization Aircraft (HC/MC-130 Recap)	2	0
Integrated Air and Missile Defense (IAMD)	2	1
Intercontinental Ballistic Missile Fuze Modernization (ICBM Fuze Mod)	1	0
Integrated Defensive Electronic Countermeasures (IDECM) Block 4	4	2
Joint Air-to-Ground Missile (JAGM)	1	0
Joint Air-to-Surface Standoff Missile (JASSM)	3	0
Joint Direct Attack Munition (JDAM)	1	1
Joint Light Tactical Vehicle (JLTV)	1	1
Joint Precision Approach and Landing System Increment 1A (JPALS Inc 1A)	1	0
Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios (JTRS HMS)	2	2
KC-130J Transport Aircraft (KC-130J)	5	1
KC-46A Tanker Modernization Program (KC-46A)	4	3
Littoral Combat Ship (LCS)	2	1
Littoral Combat Ship - Mission Modules (LCS Packages)	0	0
LHA 6 America Class Amphibious Assault Ship (LHA 6)	1	1
LPD 17 San Antonio Class Amphibious Transport Dock (LPD 17)	1	1
MH-60R Multi-Mission Helicopter (MH-60R)	4	0
Multifunctional Information Distribution System (MIDS)	6	4
MQ-1C Gray Eagle Unmanned Aircraft System (MQ-1C Gray Eagle)	4	4
MQ-4C Triton Unmanned Aircraft System (MQ-4C Triton)	1	1
MQ-8 Fire Scout	1	1
MQ-9 Reaper Unmanned Aircraft System (MQ-9 Reaper)	2	0

Program name	Number of contracts listed in the December 2015 SAR	Contracts with an accepted individual subcontracting report (as of October 2016)
Mobile User Objective System (MUOS)	1	0
Navy Multiband Terminal (NMT)	2	0
Next Generation Operational Control System (GPS OCX)	0	0
P-8A Poseidon Multi-Mission Maritime Aircraft (P-8A)	2	1
Patriot Advanced Capability-3 Missile Segment Enhancement (PAC-3 MSE)	3	0
M109A7 Family of Vehicles (M109A7 FOV)	0	0
Remote Minehunting System (RMS)	0	0
Space Based Infrared System High (SBIRS High)	4	0
Small Diameter Bomb Increment II (SDB II)	1	0
Standard Missile-6 (SM-6)	3	0
Space Fence Ground-Based Radar System Increment 1	1	0
Ship to Shore Connector Amphibious Craft (SSC)	1	1
SSN 774 Virginia Class Submarine (SSN 774)	2	2
Tactical Tomahawk RGM-109E/UGM 109E Missile (TACTOM)	2	0
Trident II (D-5) Sea-Launched Ballistic Missile UGM 133A (Trident II Missile)	11	0
UH-60M Black Hawk Helicopter (UH-60M Black Hawk)	1	0
V-22 Osprey Joint Services Advanced Vertical Lift Aircraft (V-22)	3	0
VH-92A Presidential Helicopter Replacement Program	1	0
Wideband Global SATCOM (WGS)	1	1
Warfighter Information Network-Tactical Increment 2 (WIN-T Inc 2)	1	0
Warfighter Information Network-Tactical Increment 3 (WIN-T Inc 3)	1	0
Totals	**190**	**62**

Source: GAO analysis of data from DOD and eSRS. | GAO-17-333SP

Appendix VII: Comments from the Department of Defense

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

ACQUISITION, TECHNOLOGY AND LOGISTICS

MAR 13 2017

Mr. Michael J. Sullivan
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G St NW
Washington, DC 20548

Dear Mr. Sullivan,

This is the Department of Defense response to the GAO Draft Report, GAO-17-333SP, "DEFENSE ACQUISITIONS: Assessments of Selected Weapon Programs," dated February 17, 2017 (GAO Code 100802).

The Department is pleased that this year's Draft Report, the 15th annual assessment on the performance of DoD's major acquisition programs, identifies many ways in which the Department continues to drive down the cost of the acquisition portfolio. GAO results appear to validate our focus on continuous improvement on the cost, schedule, and performance measures of our programs using the Better Buying Power and other initiatives.

The USD(AT&L) will again publish a comprehensive report on the acquisition system in the Summer of 2017. We appreciated the opportunity in previous years to host question and answer sessions regarding our report with members of your staff, and look forward to continuing to share information and best practices in the future.

The Department appreciates the opportunity to comment on the Draft Report. Technical comments will be provided separately. My point of contact for this effort is CDR Joseph Mitzen, 703-697-8020.

Sincerely,

Dyke D. Weatherington
Performing the Duties of
Assistant Secretary of Defense for
Acquisition

Appendix VIII: GAO Contact and Staff Acknowledgments

GAO Contact

Michael J. Sullivan, (202) 512-4841 or sullivanm@gao.gov

Staff Acknowledgments

Principal contributors to this report were Christopher R. Durbin, Assistant Director; Desirée E. Cunningham; Matthew T. Drerup; Danny G. Owens; Wendy P. Smythe; Patrick R. Tierney; and J. Andrew Walker. Other key contributors included, Matthew Ambrose, Cheryl K. Andrew, Sonja J. Bensen, David B. Best, Emily Bond, Edwin B. Booth, Julie C. Hadley, Rich Horiuchi, J. Kristopher Keener, Julia Kennon, Jill N. Lacey, Katherine Lenane, Travis J. Masters, LaTonya D. Miller, Diana Moldafsky, Meghan C. Perez, Beth Reed Fritts, Max B. Sawicky, Ronald E. Schwenn, William Shear, Charlie Shivers, Roxanna T. Sun, Jay Tallon, Bruce H. Thomas, Kristin VanWychen, and Alyssa B. Weir.

Table 11 lists the staff responsible for individual programs:

Table 11: Staff Responsible for Individual Program Assessments

Program name / Current programs	Primary staff
Air and Missile Defense Radar (AMDR)	Sean D. Merrill, LeAnna M. Parkey
Airborne & Maritime/Fixed Station (AMF)	R. Eli DeVan
Amphibious Combat Vehicle (ACV)	Bonita J. P. Oden, Patrick R. Tierney
Armored Multi-Purpose Vehicle (AMPV)	Charlie Shivers, Marcus C. Ferguson, Andrea C. Evans
B-2 Defensive Management System Modernization (B-2 DMS-M)	Matthew B. Lea, Don M. Springman
CH-53K Heavy Lift Replacement Helicopter	Robert K. Miller, Victoria C. Klepacz
Combat Rescue Helicopter (CRH)	Sean C. Seales, Matthew T. Drerup
Common Infrared Countermeasure (CIRCM)	Danny G. Owens, Wendy P. Smythe
CVN 78 Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)	Jessica E. Karnis, Burns C. Eckert, Marcia Fernandez
DDG 51 Flight III Destroyer (DDG 51 Flight III)	Laura M. Jezewski, Karen L. Cassidy
DDG 1000 Zumwalt Class Destroyer (DDG 1000)	Ramzi N. Nemo, Angie Nichols-Friedman
Enhanced Polar System (EPS)	Andrew Redd, Bradley L. Terry

Program name / Current programs	Primary staff
Evolved Expendable Launch Vehicle (EELV)	Erin E. Cohen, Andrew Redd
F-15 Eagle Passive Active Warning Survivability System (F-15 EPAWSS)	Matthew T. Drerup, LeAnna M. Parkey
F-22 Increment 3.2B Modernization (F-22 Inc 3.2B Mod)	Nathaniel Vaught, Sean C. Seales
F-35 Lightning II Program (F-35 JSF)	Jillena S. Roberts, Megan L. Setser
Family of Advanced Beyond Line-of-Sight Terminals (FAB-T)	Alexandra Dew Silva, Scott M. Purdy
Global Positioning System III (GPS III)	Jonathan Mulcare, Erin E. Cohen
Ground/Air Task Oriented Radar (G/ATOR)	Joe E. Hunter, Claire Li, Jonathan Munetz
Indirect Fire Protection Capability Increment 2 – Intercept, Block 1	Brian T. Smith
Integrated Air and Missile Defense (IAMD)	Julie C. Hadley, Meredith A. Kimmett
Joint Air-to-Ground Missile (JAGM)	Jessica M. Berkholtz, John W. Crawford
Joint Light Tactical Vehicle (JLTV)	Marcus C. Ferguson, Ethan I. Levy, Andrea C. Evans
Joint Precision Approach and Landing System Increment 1A (JPALS Inc 1A)	Stephen V. Marchesani, Jennifer A. Dougherty
Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios (JTRS HMS)	Scott M. Purdy, Jessica E. Karnis
KC-46A Tanker Modernization Program (KC-46A)	Katheryn S. Hubbell, Nathaniel Vaught
LHA 6 America Class Amphibious Assault Ship (LHA 6)	Alexis S. Olson, Mackenzie D. Verniero
Littoral Combat Ship (LCS)	Jacob L. Beier, Laurier R. Fish
Littoral Combat Ship - Mission Modules (LCS Packages)	Laurier R. Fish, Jacob L. Beier
M109A7 Family of Vehicles (M109A7 FOV)	Billy Allbritton, George A. Bustamante, Jr.
Military Global Positioning System User Equipment Increment 1 (MGUE Inc 1)	Claire Buck, Patrick Breiding
MQ-4C Triton Unmanned Aircraft System (MQ-4C)	Matthew M. Shaffer, Don M. Springman
MQ-8 Fire Scout Unmanned Aircraft System (MQ-8 Fire Scout)	James S. Kim, Justin M. Jaynes
Next Generation Jammer Increment 1 (NGJ Inc 1)	Laura T. Holliday, Daniel J. Glickstein
Next Generation Operational Control System (OCX)	Patrick Breiding, Claire Buck
Offensive Anti-Surface Warfare Increment 1 (OASuW Inc 1)	Thomas P. Twambly, Leslie C. Ashton
Columbia Class Ballistic Missile Submarine (SSBN) (formerly Ohio Replacement)	James Madar, Herbert J. Bowsher
P-8A Increment 3 Upgrade Program (P-8A Inc 3)	Heather B. Miller, Jocelyn C. Yin
Patriot Advanced Capability-3 Missile Segment Enhancement (PAC-3 MSE)	Meredith Allen Kimmett, Brian T. Smith
Ship to Shore Connector Amphibious Craft (SSC)	Teague A. Lyons, Matthew M. Shaffer
Small Diameter Bomb Increment II (SDB II)	John W. Crawford, Jessica M. Berkholtz
Space Fence Ground Based Radar System Increment 1 (Space Fence Inc 1)	Laura D. Hook, Mary C. Diop
Three-Dimensional Expeditionary Long-Range Radar (3DELRR)	Claire Li, Joe E. Hunter
VH-92A Presidential Helicopter (VH-92A)	Bonita J. P. Oden, Ramzi N. Nemo

Program name / Current programs	Primary staff
Warfighter Information Network-Tactical Increment 2 (WIN-T Inc 2)	Ryan Stott, Guisseli Reyes Turnell

Program Name / Future Programs	Primary Staff
Advanced Pilot Trainer (APT)	Marvin E. Bonner, Meghan C. Perez
Amphibious Ship Replacement (LX(R))	Holly N. Williams
Improved Turbine Engine Program (ITEP)	Wendy P. Smythe, Danny G. Owens
Joint Surveillance Target Attack Radar System Recapitalization (JSTARS Recap)	J. Andrew Walker, Sameena Ismailjee
Long Range Precision Fires (LRPF)	George A. Bustamante, Jr., Billy Allbritton
MQ-25 Unmanned Aircraft System (MQ-25) (formerly UCLASS)	Robert P. Bullock, Julie C. Hadley
Frigate	Sean D. Merrill, LeAnna M. Parkey
Presidential Aircraft Recapitalization (PAR)	LeAnna M. Parkey, Wendell K. Hudson
John Lewis Class Fleet Replenishment Oiler (T-AO 205)(formerly T-AO(X))	Jocelyn C. Yin, Jenny Chow
Weather System Follow-on—Microwave (WSF-M)	Brenna Derritt, Maricela Cherveny

Source: GAO. | GAO-17-333SP

Appendix IX: Accessible Data

Data Tables

Data Table for Figure 1: Defense Acquisition System

DOD acquisition milestones	Development start (Milestone B)	System development	Production start (Milestone C)
Technology Development	Integration	Demonstration	Production
GAO knowledge points	Knowledge point 1 Technologies and resources match requirements	Knowledge point 2 Design performs as expected	Knowledge point 3 Production can meet cost, schedule, and quality targets

Data Table for Figure 2: DOD Portfolio Cost and Size, 2006-2016

Year	Total acquisition cost	Number of programs
2006	1665	88
2007	1702.3	94
2008	1683.9	95
2010	1781.1	97
2011	1711.4	95
2012	1548.2	85
2013	1532.7	80
2014	1470.5	78
2015	1455.5	79
2016	1464.7	78

Data Table for Figure 3: Distribution of the 1-year Change in Total Acquisition Cost for the 2016 Portfolio

	Change	Amount of cost change in each percentage interval over the past year	Number of programs in each percentage cost change interval
32 programs with cost decreases	< -25%	-0.71	1
	-25-20%	0	0
	-20-15%	-3.75	1
	-15-10%	0	0
	-10-5%	-0.83	3
	-5-0%	-12.16	27
46 programs with cost increases	0-5%	8.03	31
	5-10%	9.3	7
	10-15%	0.98	2
	15-20%	1.81	3
	20-25%	1.23	2
	> 25%	5.47	1

Data Table for Figure 4: DOD Portfolio Future Development and Procurement Funding in Comparison to Invested Funding by Year, 2006-2016

Year	Procurement funding needed to complete the portfolio	Development funding needed to complete the portfolio	Total development and procurement funding invested in the portfolio
2006	114.5	852.3	-661.4
2007	96.5	830.1	-737.4
2008	77.8	740.9	-826.5
2010	51.8	675.5	-953.9
2011	57.2	698.8	-919.4
2012	44.4	643.2	-820.4
2013	37.6	658	-853.3
2014	33.2	617.5	-807
2015	32.4	577.7	-832.2
2016	27.6	546	-878.1

Data Table for Figure 5: Development and Procurement Cost Growth between Key Milestones for Programs Included in DOD's 2016 Portfolio

	Total estimated procurement cost growth	Total estimated research and development cost growth
Development start to critical design review	25.7	52
Critical design review to production decision	21	69.7
Production start to end of production	32.1	221.5
Development start through end of production	78.7	343.2

Data Table for Figure 6: Comparison of the Cost Performance of DOD's 2012-2016 Portfolios

	Year	Percentage of programs that meet the cost growth metric	Percentage of programs that do not meet the cost growth metric
1-year comparison (<2% growth)	2012	85	15
	2013	76	24
	2014	69	31
	2015	76	24
	2016	72	28
5-year comparison (<10% growth)	2012	56	44
	2013	55	45
	2014		
	2015	72	28
	2016	78	22
First full estimate comparison (<15% growth)	2012	48	52
	2013	44	56
	2014	44	56
	2015	47	53
	2016	46	54

Data Table for Figure 7: Ten Percent of DOD's Total Acquisition Cost Is for the 19 Programs Initiated in or after 2010 and 90 Percent Is for the Remaining 58 Programs and the F-35 Lightning II

- 23% of the total acquisition cost is for F-35 Lightning II, $336.15 billion
- 10% of the total acquisition cost is for 19 programs initiated in or after 2010, $147.15 billion
- 67% of the total acquisition cost is for 58 programs initiated before 2010, $981.45 billion

Data Table for Figure 8: Distribution of the 1-year Change in Total Acquisition Cost for the Programs Initiated before 2010 and the Programs Initiated in or after 2010

	Amount of cost change in each percentage interval over the past year for programs initiated before 2010	Amount of cost change in each percentage interval over the past year for programs initiated in or after 2010	Number of programs in each percentage change cost interval for programs initiated before 2010	Number of programs in each percentage change cost interval for programs initiated in or after 2010
< -25%	-0.71	NA	1	NA
-25-20%	0	NA	0	NA
-20-15%	0	-3.75	0	1
-15-10%	0	0	0	0
-10-5%	-0.72	-0.11	2	1
-5-0%	-11.23	-0.94	20	7
0-5%	7.77	0.26	24	7
5-10%	8.74	0.56	5	2
10-15%	0.98	0	2	0
15-20%	1.23	0.57	2	1
20-25%	1.23	NA	2	NA
> 25%	5.47	NA	1	NA

Data Table for Figure 9: Programs' Timing of Declaring Initial Operational Capability and Completing Initial Operational Test and Evaluation

Not applicable – 16

Capability declared before testing – 7

- Cooperative Engagement Capability (CEC)
- Combat Rescue Helicopter (CRH)
- Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)
- Global Broadcast Service (GBS)
- Ground/Air Task Oriented Radar (G/ATOR)
- Littoral Combat Ship (LCS)
- SSN 774 Virginia Class Submarine (SSN 774)

Capability declared during testing – 31

- AGM-88E Advanced Anti-Radiation Guided Missile (AGM-88E AARGM)
- AH-64E Apache New Build (AH-64E New Build)
- AH-64E Apache Remanufacture (AH-64E Remanufacture)
- Armored Multi-Purpose Vehicle (AMPV)
- B-2 Extremely High Frequency SATCOM and Computer Increment 1 (B-2 EHF Inc1)
- DDG 1000 Zumwalt Class Destroyer (DDG 1000)
- DDG 51 Arleigh Burke Class Guided Missile Destroyer (DDG 51)
- E-2D Advanced Hawkeye Aircraft (E-2D AHE)
- EA-18G Growler Aircraft (EA-18G)
- F-22 Increment 3.2B Modernization (F-22 Inc 3.2B Mod)
- F-35 Lightning II Program (F-35)
- HC/MC-130 Recapitalization Aircraft (HC/MC-130 Recap)
- Integrated Defensive Electronic Countermeasures (IDECM) Block 4
- Joint Air-to-Ground Missile (JAGM)

- Joint Precision Approach and Landing System Increment 1A (JPALS Inc 1A)
- Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios (JTRS HMS)
- KC-46 Tanker Modernization Program (KC-46A)
- LHA 6 America Class Amphibious Assault Ship (LHA 6)
- LPD 17 San Antonio Class Amphibious Transport Dock (LPD 17)
- M109A7 Family of Vehicles (M109A7 FOV)
- MH-60R Multi-Mission Helicopter (MH-60R)
- MQ-4C Triton Unmanned Aircraft System (MQ-4C Triton)
- MQ-9 Reaper Unmanned Aircraft System (MQ-9 Reaper)
- Multifunctional Information Distribution System (MIDS)
- Navy Multiband Terminal (NMT)
- Next Generation Operational Control System (GPS OCX)
- Patriot Advanced Capability-3 Missile Segment Enhancement (PAC-3 MSE)
- Remote Minehunting System (RMS)
- Ship to Shore Connector Amphibious Craft (SSC)
- Small Diameter Bomb Increment II

Capability declared after testing - 24

Data Table for Figure 10: Recipients of the $23.6 Billion in Total Realized “Should-cost” Savings

Other priorities	Kept in program	Went to outside service priorities	Went to service priorities	Recipient unknown
1.1	2.1	3.3	6.1	11.1

Data Table for Figure 11: Competitive Prototyping Plans among 54 Future and Current Programs

	Will conduct competitive prototyping	Will not conduct competitive prototyping
Future programs	1	8
Current programs	22	23

Data Table for Figure 12: Defense Acquisition Cycle and GAO Knowledge Points

	Technology Development Phase	Integration Phase	Demonstration Phase	Production Phase
Milestone	NA	Development start (Milestone B) Preliminary design review (PDR)	System development Critical design review (CDR)	Production start (Milestone C)
Knowledge Point	NA	Knowledge Point 1 • Technologies, time, funding and other resources match customer needs. • Decisions to invest in product development.	Knowledge Point 2 • Design is stable and performs as expected. • Decisions to start building and testing production representative prototypes.	Knowledge Point 3 • Production meets cost, schedule, and quality target. • Decisions to produce first units for customer.
key steps	NA	• PDR completed • Technologies demonstrated to high levels • Incremental acquisition strategy in place • Knowledge-based cost estimate	• Subsystems and system level CDRs completed • Ninety percent of engineering drawings released • Early integrated system prototype demonstrated • Critical manufacturing process identified	• Fully integrated, capable prototype demonstrated in intended environment. • Manufacturing processes in control • Product reliability demonstrated

Data Table for Figure 16: Illustration of Program Two-Page Assessment

Element	Explanation
A	Program description
B	Illustration or photo of system
C	Schedule timeline identifying key dates for the program including the start of development, major design reviews, production decisions, and planned operational capability
D	Program Essentials Programmatic information including the prime contractor, program office location, and funding needed to complete
E	Program Performance Cost and schedule baseline estimates and the latest estimate provided as of January 2017

Element	Explanation
F	Brief summary describing the program's implementation of knowledge-based acquisition practices and its current status
G	Attainment of Product Knowledge Depiction of selected knowledge-based practices and the program's progress in attaining that knowledge
H	Assessment of program's technology, design, and production maturity, as well as other program issues
I	Program Office Comments General comments provided by the cognizant program office

Agency Comment Letter

Text of Appendix VII: Comments from the Department of Defense

Mr. Michael J. Sullivan

Director, Acquisition and Sourcing Management

U.S. Government Accountability Office 441 G St NW

Washington, DC 20548 Dear Mr. Sullivan,

MAR 13, 2017

This is the Department of Defense response to the GAO Draft Report, GAO- I 7-333SP, "DEFENSE ACQUISITIONS: Assessments of Selected Weapon Programs ," dated February 17, 2017 (GAO Code 100802).

The Department is pleased that this year's Draft Report, the 15th annual assessment on the performance of DoD's major acquisition programs , identifies many ways in which the Department continues to drive down the cost of the acquisition portfolio. GAO results appear to validate our focus on continuous improvement on the cost, schedule, and performance measures of our programs using the Better Buying Power and other initiatives.

The USD(AT&L) will again publish a comprehensive report on the acquisition system in the Summer of 2017. We appreciated the opportunity in previous years to host question and answer sessions regarding our ·report with members of your staff, and look forward to continuing to share information and best practices in the future.

The Department appreciates the opportunity to comment on the Draft Report. Technical comments will be provided separately. My point of contact for this effort is CDR Joseph Mitzen, 703-697-8020.

Sincerely,

Dyke D. Weatherington Performing the Duties of

Assistant Secretary of Defense for Acquisition

Related GAO Products

High-Risk Series: Progress on Many High-Risk Areas, While Substantial Efforts Needed on Others. GAO-17-317. (Washington, D.C.: Feb. 15, 2017).

Littoral Combat Ship and Frigate: Slowing Planned Frigate Acquisition Would Enable Better-Informed Decisions. GAO-17-279T. Washington, D.C.: Dec. 8, 2016.

Weapon System Requirements: Detailed Systems Engineering Prior to Product Development Positions Programs for Success. GAO-17-77. Washington, D.C.: Nov. 17, 2016.

Defense Acquisitions: Assessments of Selected Weapon Programs. GAO-16-329SP. Washington, D.C.: Mar. 31, 2016.

KC-46 Tanker Aircraft: Key Aerial Refueling Capabilities Should Be Demonstrated Prior to the Production Decision. GAO-15-308. Washington, D.C.: Apr. 9, 2015.

Federal Subcontracting: Linking Small Business Subcontractors to Prime Contracts Is Not Feasible Using Current Systems. GAO-15-116. Washington, D.C.: Dec. 11, 2014.

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Best Practices: DOD Can Achieve Better Outcomes by Standardizing the Way Manufacturing Risks Are Managed. GAO-10-439. Washington, D.C.: Apr. 22, 2010.

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Defense Acquisitions: A Knowledge-Based Funding Approach Could Improve Major Weapon System Program Outcomes. GAO-08-619. Washington, D.C.: July 2, 2008.

Defense Acquisitions: Stronger Management Practices are Needed to Improve DOD's Software-Intensive Weapon Acquisitions. GAO-04-393. Washington, D.C.: Mar. 1, 2004.

Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes. GAO-02-701. Washington, D.C.: July 15, 2002.

Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes. GAO-01-288. Washington, D.C.: Mar. 8, 2001.

Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes. GAO/NSIAD-99-162. Washington, D.C.: July 30, 1999.

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