United States Government Accountability Office

Report to Congressional Committees

March 2015

DEFENSE ACQUISITIONS

Assessments of Selected Weapon Programs

Accessible Version

On April 9, 2015 GAO re-issued this report to reflect changes made to the quantities of one of the programs used in our calculations. This resulted in a revision of the analysis of the reasons for cost change in programs on page 13 and the analysis of changes to program buying power presented on the Highlights page, page 6, and pages 14 through 16.

GAO-15-342SP

GAO Highlights

Highlights of GAO-15-342SP, a report to congressional committees

March 2015

DEFENSE ACQUISITIONS

Assessments of Selected Weapon Programs

Why GAO Did This Study

This is GAO's annual assessment of DOD weapon system acquisitions, an area on GAO's high-risk list. DOD and Congress have taken meaningful steps to improve the acquisition of major weapon systems, yet programs continue to experience cost and schedule overruns. Further, GAO has emphasized the need to sustain the implementation of acquisition reforms and complete developmental testing before beginning production. With the continuing budgetary pressures, DOD cannot afford to miss opportunities to address inefficiencies in these programs to free up resources for higher priority needs.

This report responds to a mandate in the joint explanatory statement to the DOD Appropriations Act, 2009. It includes observations on (1) the cost and schedule performance of DOD's 2014 portfolio of 78 major defense acquisition programs; (2) the knowledge attained at key junctures in the acquisition process for 38 programs that were in development or early production; and (3) key acquisition reform initiatives and program concurrency. To develop the observations in this report, GAO analyzed cost, schedule, and quantity data from DOD's December 2013 Selected Acquisition Reports. GAO also collected data through two questionnaires to program offices 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 noted that it was encouraged by the performance of its programs and will continue to seek improvements.

View GAO-15-342SP. For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov

What GAO Found

Over the past year, the overall size of DOD's major defense acquisition program portfolio decreased, from 80 programs to 78, while the estimated cost has decreased by $7.6 billion. The size and cost of the portfolio is currently the lowest in a decade. The decrease in current portfolio cost is due primarily to significant quantity decreases on two programs—most other programs actually experienced a cost increase over the past year. The average time to deliver initial capability to the warfighter also increased by over 1 month. Forty-one programs in the portfolio lost buying power during the past year resulting in $5.3 billion in additional costs, a contrast to the buying power gains seen in GAO's prior assessments. The F-35, the costliest program in the portfolio, epitomizes this loss in buying power as its costs have risen over the past year without any change in quantity, meaning it is paying more for the same amount of capability.

Buying Power Analysis for the 2014 Portfolio (Fiscal year 2015 dollars in billions)

	Number of programs	Actual procurement cost change	Change attributable to quantity changes	Change not attributable to quantity changes
Programs that lost buying power	40	$8.7	-$9.0	$17.7
Programs that gained buying power	34	-$16.7	-$1.3	-$15.4
Programs with no change in buying power	4	$0.0	$0.0	$0.0
Portfolio totals	**78**	**-$8.1**	**-$10.3**	**$2.2**

Source: GAO analysis of DOD data. | GAO-15-342SP

Note: Some numbers may not sum up due to rounding.

Most of the 38 programs GAO assessed this year are not yet fully following a knowledge-based acquisition approach. This held true for the six programs that recently entered system development. Each implemented some knowledge based practices—such as constraining the period for development—but some practices—such as fully maturing technologies prior to system development start and completing systems engineering reviews—were not fully implemented. As a result, programs will carry unwanted risk into subsequent phases of acquisition that could result in cost growth or schedule delays.

Implementation of the reform initiatives GAO analyzed varies for the 38 programs assessed above as well as the 15 assessed that will become programs in the future. While more programs are implementing acquisition reform initiatives now than in past assessments—such as the use of affordability constraints and increased opportunities for competition—several programs requiring significant funding commitments have received waivers from components of a mandatory certification at system development start. However, concurrently conducting both software and hardware development during production may be exposing programs to undue cost and schedule risk.

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Abbreviations

AMPV	Armored Multi-Purpose Vehicle
BMDS	Ballistic Missile Defense System
CRH	Combat Rescue Helicopter
CSAR-X	Combat Search and Rescue Replacement Vehicle
CSB	Configuration Steering Board
DAMIR	Defense Acquisition Management Information Retrieval
DOD	Department of Defense
eSRS	Electronic Subcontracting Reporting System
EPS	Enhanced Polar System
MDAP	Major Defense Acquisition Program
MRL	manufacturing readiness level
NA	not applicable
OMB	Office of Management and Budget
SAR	Selected Acquisition Report
SDB II	Small Diameter Bomb Increment II
SSC	Ship to Shore Connector Amphibious Craft
TBD	to be determined
TRL	technology readiness level
WIN-T	Warfighter Information Network-Tactical
WSARA	Weapon Systems Acquisition Reform Act
3DELRR	Three Dimensional Expeditionary Long Range Radar

U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Comptroller General
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March 12, 2015

Congressional Committees

I am pleased to present GAO's 13th annual assessment of the Department of Defense's (DOD) major defense acquisition programs. This report offers observations on the performance of DOD's current $1.4 trillion portfolio of 78 programs, the smallest portfolio in terms of cost and number of programs in a decade.[1] Despite the decrease in portfolio size, these 78 programs require approximately 30 percent of all development and procurement funding for all DOD acquisition programs over the next 5 years. Given the magnitude of the investment at stake in these programs in a time of continuing budgetary constraints, DOD cannot afford to pass up any opportunity to address inefficiencies and free up resources for higher priority needs. In our prior assessments, we reported that Congress and DOD had taken steps to address long-standing problems with DOD acquisitions—an area that has been on GAO's high-risk list for 23 years—by making legislative and policy changes that endorse a knowledge-based acquisition approach.[2] As a result of these initiatives, some programs have realized significant cost savings or avoided cost and schedule growth. However, not all of these initiatives have been implemented to the same extent, and as a result, some programs may be less successful at avoiding future cost and schedule growth than others.

Our current assessment shows that the estimated cost of DOD's 2014 portfolio of major defense acquisition programs is $90 billion less than the 2013 portfolio and decreased from 80 to 78 programs as well. As a result, the portfolio is the smallest it has been in a decade. Similarly, the cost of the 78 programs in the 2014 portfolio has decreased by more than $7 billion over the past year, a net cost decrease partially attributable to significant quantity reductions in two programs—the Littoral Combat Ship and the Warfighter Information Network—Tactical Increment 3. However, the portfolio's overall cost decrease is not necessarily indicative of the performance of every program, as costs on 47 of the 78 programs

[1]Our assessment of DOD's portfolio does not include the cost of the Ballistic Missile Defense System (BMDS) which we exclude as the program lacks an acquisition program baseline needed to support our assessment of cost and schedule change. For more information on BMDS, see GAO, *Missile Defense: Mixed Progress in Achieving Acquisition Goals and Improving Accountability,* GAO-14-351 (Washington, D.C.: April 1, 2014).

[2]GAO, *High-Risk Series: An Update*, GAO-15-290 (Washington, D.C.: February 11, 2015).

increased over the past year. This undesirable cost performance shows the need for continued oversight.

Our assessment also shows that the implementation of knowledge-based acquisition practices among programs is showing little improvement as programs continue to progress through the acquisition cycle without the appropriate levels of knowledge at key junctures, making them less likely to achieve their cost, schedule, and performance objectives. Of particular concern are those programs that have recently entered system development before satisfying best practices, leaving them at risk for future cost and schedule growth. However, our analysis shows that more programs are implementing selected acquisition reforms focused on affordability, cost savings, and competition than in the past, although DOD continues to accept risks by allowing programs to waive important certifications at the start of their development or to begin production before completing developmental testing. This report also includes brief assessments of 38 current and 15 future major defense programs that provide additional insights at a programmatic level.

Continued strong leadership on the part of DOD is essential in enforcing a broader implementation of best practices in all aspects of weapon system acquisition. Today, more programs are using acquisition strategies and program management tools to find efficiencies and reduce costs while still providing the needed capability. Given the prospect of shrinking or stagnant defense budgets, it is important that the department continue and even increase the use of these practices, as well as more fully implement the other best practices we assessed to avoid the problematic strategies of the past. The potential for savings and for better serving the warfighter argue against complacency.

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March 12, 2015

Congressional Committees

In response to the mandate in the joint explanatory statement to the Department of Defense Appropriations Act, 2009, this report provides insight into the department's $1.4 trillion portfolio of major weapon programs.[1] Since we began conducting this assessment in 2003, Congress and DOD have improved the statutory and policy framework that defines the defense acquisition system, encouraging a knowledge-based approach for all of its major weapon programs. Despite this, some programs are still experiencing cost growth and schedule delays. Additionally, this report 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]

This report includes observations on (1) the cost and schedule performance of DOD's 2014 portfolio of 78 major defense acquisition programs, (2) the knowledge attained at key junctures in the acquisition process for 38 weapon programs in development or early production, and (3) key acquisition reform initiatives and whether programs are conducting or planning concurrent testing and production.[3]

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

[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]Major defense acquisition programs (MDAP) are those identified by DOD 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 major defense acquisition programs throughout this report.

- We assessed 78 major defense acquisition programs in DOD's 2014 portfolio for our analysis of cost and schedule performance. We obtained cost, schedule, and quantity data from DOD's December 2013 Selected Acquisition Reports (SAR) and from the Defense Acquisition Management Information Retrieval Purview system. We assessed the reliability of the data by interviewing knowledgeable agency officials, and determined that the data were sufficiently reliable for the purposes of this report.

- We assessed 38 major defense acquisition programs currently between the start of development and the early stages of production for knowledge attained at key junctures, the implementation of acquisition reforms, and their acquisition strategies. We obtained information on the extent to which the programs follow knowledge-based practices—established by the body of work included in the Related GAO Products section of this report—for technology maturity, design stability, and production maturity using two data-collection instruments, including a questionnaire on issues such as systems engineering reviews, design stability, manufacturing planning and execution, and the implementation of specific acquisition reforms. We received questionnaire responses from all 38 current programs from July through September 2014.

- We assessed 15 future major defense acquisition programs in order to gain additional insights into knowledge attained before the start of development and the 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 15 future programs from August through September 2014.

In addition to our observations on these sets of programs, we present individual assessments of 53 weapon programs. These programs include major defense acquisition programs currently in development or early production, and future programs. Appendix I contains detailed information on our scope and methodology.

We conducted this performance audit from June 2014 to March 2015 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 based on our audit objectives.

Observations on the Cost and Schedule Performance of DOD's 2014 Major Defense Acquisition Program Portfolio

The estimated cost of DOD's 2014 portfolio of 78 major weapon system acquisition programs is $90 billion less than the 2013 portfolio of 80 programs. The 78 programs within this year's portfolio also report cost decreases of $7.6 billion against their estimates from a year ago and a 1 month average increase to the schedule for delivery of initial capabilities. The majority of the overall cost decrease in the 2014 portfolio can be attributed to two programs that achieved significant cost decreases through quantity reductions. The overall cost decrease masks two negative trends, as the majority of programs actually experienced a cost increase over the past year, and more than half of the 78 program in the portfolio reported cost increases not related to quantity changes, which we refer to as a loss in buying power. The $7.6 billion net cost decrease over the past year should also be considered in light of the cost and schedule increases since first full estimates were made. Our analysis of DOD's 2014 portfolio allows us to make the following nine observations.

Cost and Schedule Performance Observations

General changes in the portfolio

1. When compared to the 2013 portfolio, the number of programs in DOD's 2014 portfolio decreased from 80 to 78, and its overall cost decreased by $90 billion from $1,526 to $1,436 billion, driven primarily by programs completing acquisition and exiting the portfolio.[a]
2. The current portfolio has the least number of programs and lowest total cost since 2004.[b] Similarly, the amount of funding needed to complete the portfolio has been steadily decreasing from 60 percent of the total cost in 2004 to 45 percent now.
3. When analyzing the change to cost and schedule estimates over the past year for the 78 programs in the 2014 portfolio, we found that costs decreased by more than $7 billion and the delivery of initial operating capability was delayed by more than one month on average. When assessed against first full estimates, the total cost of the 2014 portfolio has increased by over $457 billion, or nearly 47 percent, with an average schedule delay of more than 29 months, or over 36 percent. These increases are proportionally higher than those seen in past assessments.

Factors that explain the changes

4. While the overall cost of the 2014 portfolio decreased, a majority of the 78 programs experienced cost increases over the past year. Significant cost estimate decreases on two programs resulted in the overall net cost decrease.
5. When the effects of quantity changes are accounted for, 40 programs in the portfolio lost buying power and 38 gained or had no change to buying power during the past year, resulting in a net cost increase of $2.2 billion. This performance over the past year diverges from the buying power gains seen in our prior assessments.
6. Schedule changes over the past year on a small number of the 78 programs contributed to the portfolio's overall delay of more than one month in the estimated delivery of their initial capability, with 11 programs reporting a delay of 6 months or more.
7. As measured against metrics discussed by GAO, the Office of Management and Budget, and DOD in 2008, 69 percent of programs meet the threshold for less than 2 percent growth in total acquisition cost over the past year, and 44 percent met the threshold for less than 15 percent cost growth since first full estimates. Both percentages are lower than those reported previously.

Other Observations

8. Thirteen of the 23 programs reporting development cost estimate increases of 2 percent or more over the past year are in production, a phase of the acquisition cycle which should have minimal development cost growth.
9. The F-35 Joint Strike Fighter, the costliest program in the portfolio since it joined in 2001, has also experienced the largest amount of cost growth since that time. If the cost and schedule performance of the F-35 is removed, the 2014 portfolio's performance improves.

[a]All dollar figures are in fiscal year 2015 constant dollars, unless otherwise noted.

[b]Details on program costs used for this analysis are provided in appendix I.

Additional details about each observation follow.

1. When compared to the 2013 portfolio, the number of programs in DOD's 2014 portfolio has decreased from 80 to 78, and its

estimated total cost has decreased by $90 billion from $1.53 to $1.44 trillion. This is primarily the result of several programs nearing the end of their planned procurement and exiting the portfolio. With 78 programs and an estimated cost of approximately $1.44 billion, the 2014 portfolio has fewer programs and a smaller total acquisition cost when compared to the 2013 portfolio. The changes from the 2013 portfolio to the 2014 portfolio are outlined in table 1 below.

Table 1: Changes in the Cost of DOD's Portfolio of Major Defense Acquisition Programs from 2013 to 2014

Fiscal year 2015 dollars (in billions)	
2013 portfolio (80 programs)	$1,526
Less estimated total cost of the 5 exiting programs	-$97
Plus estimated total cost of the 3 entering programs	+$13
Less net cost changes on the 75 remaining programs	-$7
2014 portfolio (78 programs)	$1,436

Source: GAO analysis of DOD data. | GAO-15-342SP

Note: Our assessment of DOD's 2013 and 2014 portfolios does not include the cost of the Ballistic Missile Defense System (BMDS), which we exclude as the program lacks an acquisition program baseline needed to support our assessment of cost and schedule change. Some numbers may not sum up due to rounding.

When all the cost changes are taken into account, the cost of the 2014 portfolio is $90 billion less than the 2013 portfolio. This difference is driven primarily by the costs of the programs exiting the portfolio, particularly the F/A-18E/F Super Hornet and Family of Medium Tactical Vehicles programs, which together account for more than $79 billion. All five programs that exited the portfolio over the past year completed their planned development and procurement; none were terminated.[4]

Three programs entered the portfolio, the Littoral Combat Ship - Mission Packages, F-22 Increment 3.2B, and Air and Missile Defense Radar. The Littoral Combat Ship - Mission Packages program started in 2004 and spent several years in system development before a milestone B decision was held in 2013 as a result of the restructuring

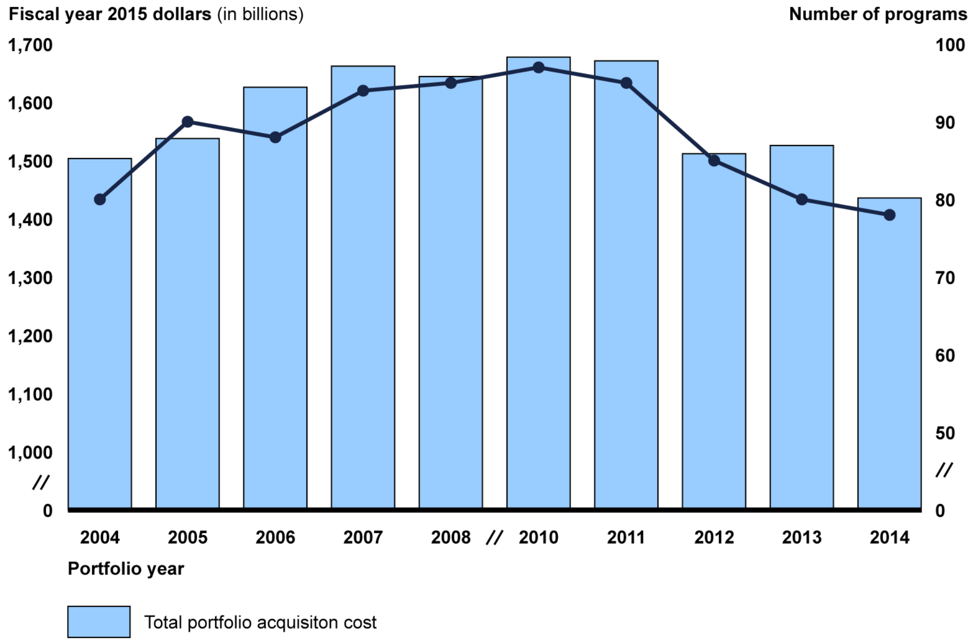
[4]The other three programs that exited the portfolio are Joint Primary Aircraft Training System, Light Utility Helicopter, and Navstar Global Positioning System.

of the Littoral Combat Ship program.[5] In contrast, the other programs were in technology development before their entry into the portfolio was approved. Each of these programs provides additional capabilities to existing weapon systems, the Littoral Combat Ship, F-22 Raptor, and DDG 51 Destroyer respectively.

2. **The number of programs in the current portfolio and their total cost are at their lowest level since 2004, and the amount of funding needed to complete the development and procurement of the programs has been steadily decreasing.** DOD's portfolio of major acquisition programs reached its peak in terms of numbers of programs and cost in 2010, and has been steadily declining since that time to a point where the current portfolio is smaller now in terms of programs and cost than any time in the last decade. Figure 1 shows the change in the cost and number of programs within DOD's portfolio of major weapon acquisitions since 2004.

[5] Milestone B normally refers to the initiation of an acquisition program as well as the start of engineering and manufacturing development or "system development start."

Figure 1: DOD Portfolio Cost and Size, 2004-2014



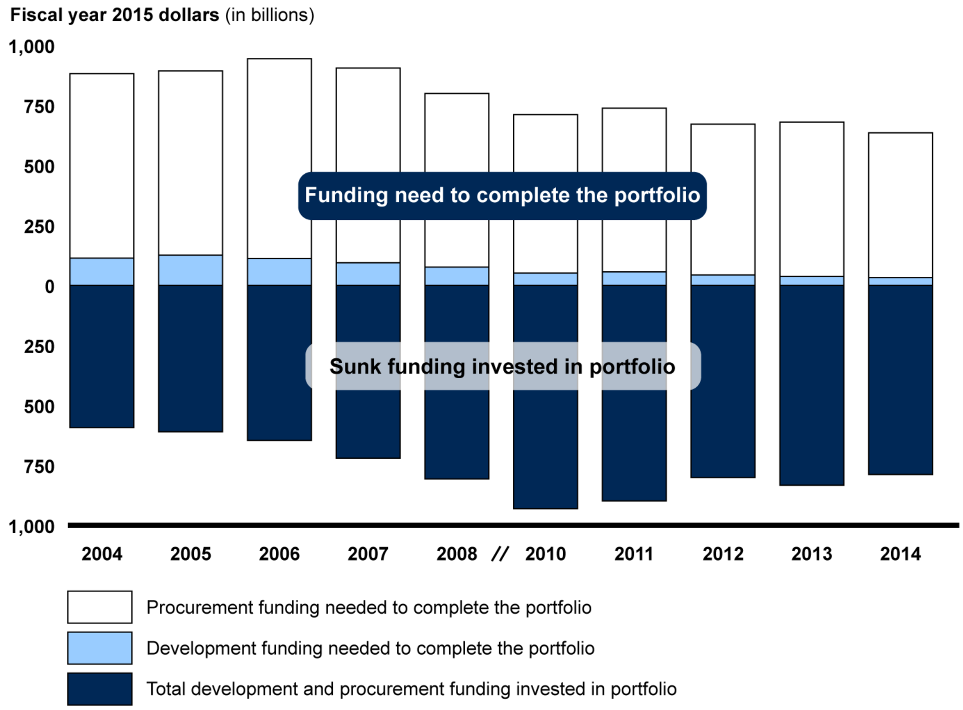
Source: GAO analysis of DOD data. | GAO-15-342SP

Note: The 2009 portfolio is excluded because there were no annual Selected Acquisition Reports released for the December 2008 submission date.

About half, or 38 of the 78 programs in the 2014 portfolio, were also in the 2004 portfolio and represent almost three-fourths of the portfolio's current total acquisition cost or $1 trillion of the $1.4 trillion total. Since 2004, these 38 programs in the portfolio have grown in cost by approximately $230 billion, which is more than 80 percent of all the cost growth reported over this time by programs currently in the portfolio.

The amount of development and procurement funding needed to complete the portfolio has also been consistently decreasing and is currently $635 billion or 45 percent of the current portfolio's total estimated cost. In 2004 the amount of funding needed to complete the portfolio was more than $880 billion or 60 percent. Figure 2 shows the change in the portfolio's future funding needs and funding invested as a share of the portfolio's total acquisition cost since 2004.

Figure 2: DOD Portfolio Future Development and Procurement Funding in Comparison to Invested Funding by Year, 2004-2014



Source: GAO analysis of DOD data. | GAO-15-342SP

Note: The 2009 portfolio is excluded because there were no annual Selected Acquisition Reports released for the December 2008 submission date.

As with total cost, the amount of development funding needed to complete the current portfolio is also at its lowest point since 2004. The estimated $32 billion needed to complete development activities is less than one-third of that needed in 2004. A contributing factor for this change is that 58 of 78 current programs are now well into production, a point when any remaining development costs should be low. In addition, in recent years, DOD has started few programs that require significant development efforts.

3. **When analyzing the change to cost and schedule estimates over the past year for the 78 programs in the 2014 portfolio, we found that costs decreased by more than $7 billion and the average schedule delay increased by more than a month.** While the first observation discusses the change from the prior portfolio of 80 programs to the current portfolio of 78 programs, this observation

addresses the change that occurred on just the 78 programs in the current portfolio. Table 2 shows the change in cost and schedule for the 2014 portfolio in the past year.

Table 2: Changes in DOD's 2014 Portfolio of 78 Major Defense Acquisition Programs over the Past Year

Fiscal year 2015 dollars (in billions)

	Estimated portfolio cost in 2013	Estimated portfolio cost in 2014	Estimated portfolio change since 2013	Percentage change since 2013
Total estimated research and development cost	$283.5	$284.9	$1.4	0.5%
Total estimated procurement cost	1,146.5	1,138.4	-8.1	-0.7
Total estimated acquisition cost[a]	1,443.4	1,435.8	-7.6	-0.5
Average delay in delivering initial capabilities from the first full estimate of cost and schedule	27.4 months	28.9 months	1.4 months additional delay	1.7

Source: GAO analysis of DOD data. | GAO-15-342SP

[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 total acquisition cost has decreased over the past year by $7.6 billion, due primarily to an $8.1 billion decrease in procurement costs which offset the $1.4 billion increase in development costs. This $7.6 billion decrease over the past year contrasts sharply with the $12.6 billion cost increase reported in our last assessment and demonstrates that the portfolio does not generally experience cost change in a linear fashion.

When assessed against first full estimates, the total cost of the 2014 portfolio increased by over $457 billion.[6] These cost estimates are consistent with the cost growth that we reported in prior assessments, but the 47 percent increase from initial estimates reported in this assessment is higher than levels we reported in the past.

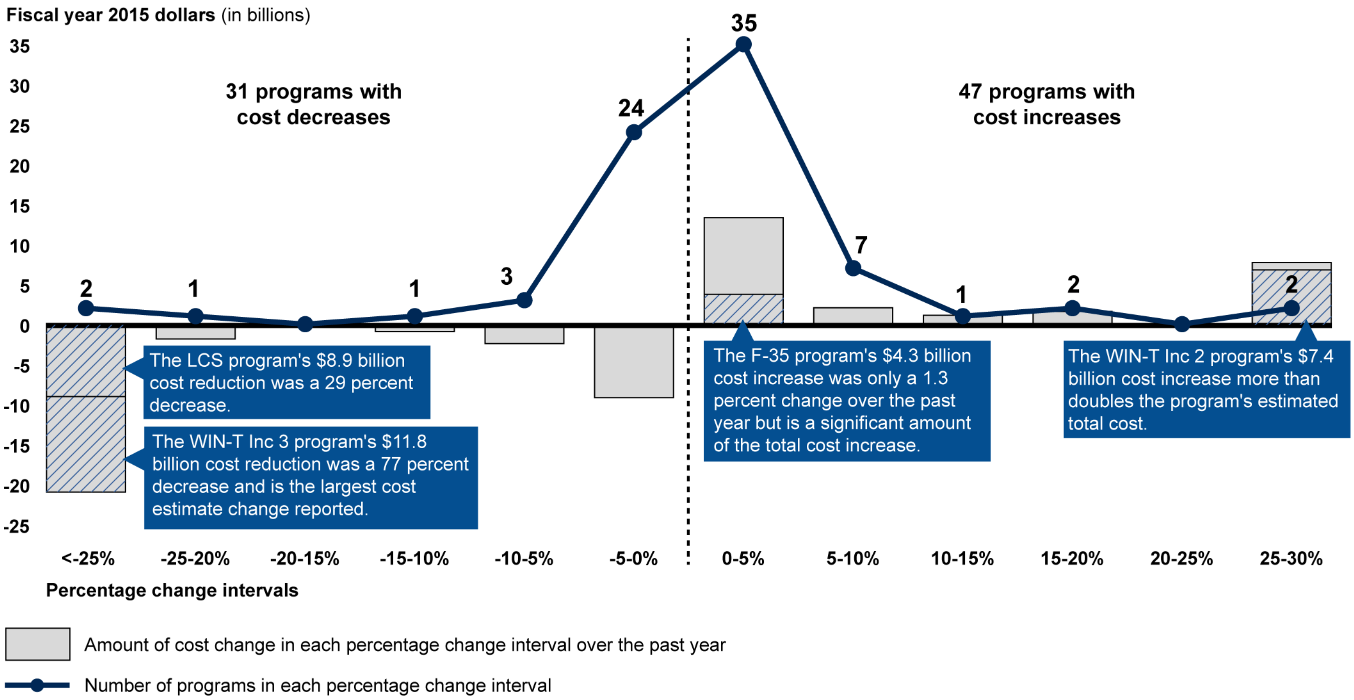
When measuring the current portfolio's schedule performance over the past year, we found that the delay in the delivery of initial operating

[6]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.

capability grew by more than a month over the past year and now stands at approximately 29 months from initial estimates.[7]

4. **While the overall cost of the 2014 portfolio decreased, 47 of the 78 programs within the portfolio experienced cost increases over the past year. The portfolio's overall cost decrease can be attributed to reductions on two programs.** The $7.6 billion decrease shown in table 2 is the net result of cost changes on all 78 programs in the current portfolio. The distribution of those cost changes across the entire portfolio is shown below in figure 3.

Figure 3: Distribution of the 1-year Change in Total Acquisition Cost within the 2014 Portfolio



Source: GAO analysis of DOD data. | GAO-15-342SP

[7]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.

Our analysis shows that 31 programs experienced cost decreases totaling $34 billion since our last assessment, while the other 47 programs report cost increases totaling $27 billion. Of the 31 programs that decreased their total acquisition cost over the past year,

- nineteen did so by finding efficiencies in the program and not by changing procurement quantities resulting in a total cost decrease of almost $5 billion;

- nine reduced their planned procurement quantities thereby reducing overall cost by more than $26 billion; and

- three programs, Evolved Expendable Launch Vehicle, MQ-4C Triton, and the V-22 Osprey, were able to reduce overall cost by a total of approximately $3 billion while increasing their planned procurement quantities.

The Warfighter Information Network-Tactical (WIN-T) Increment 3 and Littoral Combat Ship programs reported the most significant decreases in cost as they both made significant reductions to their procurement quantities over the past year. For example, the WIN-T Increment 3 program reported a cost decrease of more than $11.8 billion due primarily to a decision to eliminate certain capabilities from the program and reduce quantities.[8] Similarly, the Littoral Combat Ship program reported a cost decrease in the past year of more than $8.9 billion due to a quantity decrease of 20 ships.[9]

In contrast, 47 programs reported total acquisition cost increases over the past year. Of these,

- thirty-one reported cost increases due to inefficiencies in the program rather than a change in procurement quantities, resulting in a total cost increase of over $13 billion;

- ten increased their planned procurement quantities, resulting in a cost increase of almost $12 billion; and

[8]As a result of acquisition decisions in May 2014 all procurement for WIN-T Increment 3 was eliminated. See the individual program assessment in this report for more information.

[9]The results of the Navy's study on future small surface combatants may further affect Littoral Combat Ship quantities.

- six experienced cost increases of almost $2 billion even though they reduced their planned procurement quantities.

The most significant of these increases was due to quantity changes. The WIN-T Increment 2 program completed a restructure that increased procurement quantity by 3167 units resulting in a cost increase of more than $7.4 billion or 146 percent over the past year. In comparison, the F-35's cost increased by $4.3 billion over the past year with no change in its procurement quantity. This increase offsets part of the $11.5 billion in cost reductions that we reported for the program in our last assessment.

As can be seen from the preceding discussion of individual cost increases and decreases, to better 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.

5. **Out of the 78 programs in the $1.4 trillion portfolio, 40 programs lost buying power and 38 either gained buying power or had no change resulting in an overall $2.2 billion buying power loss after two consecutive years of gains.** In general, buying power can be defined as the amount of goods or services that can be purchased given a specified level of funding. Although procurement costs for the portfolio have decreased by $8.1 billion over the past year, this decrease is less than anticipated. Specifically, our calculations of the expected cost reduction due to quantity changes over this period, indicated there was an overall decrease in buying power.[10] Our calculation of how programs' cost and quantity changes affected their buying power is presented in table 3.

[10]A description of the calculation used can be found in appendix I.

Table 3: Buying Power Analysis for the 2014 Portfolio

Fiscal year 2015 dollars (in billions)

	Number of programs	Actual procurement cost change	GAO-calculated cost change attributable to quantity changes	GAO-calculated cost change not attributable to quantity changes
Programs that lost buying power	**40**	**$8.7**	**-$9.0**	**$17.7**
Procurement cost increased with no quantity change	26	$12.3	$0.0	$12.3
Quantity increased with more cost increase than anticipated	3	$8.2	$7.7	$0.5
Quantity decreased with less cost decrease than anticipated	11	-$11.9	-$16.7	$4.9
Programs that gained buying power	**34**	**-$16.7**	**-$1.3**	**-$15.4**
Procurement cost decreased with no quantity change	21	-$3.8	$0.0	-$3.8
Quantity increased with less cost increase than anticipated	10	$0.1	$10.6	-$10.5
Quantity decreased with more cost decrease than anticipated	3	-$13.0	-$11.9	-$1.1
Programs with no change in buying power	**4**	**$0.0**	**$0.0**	**$0.0**
Portfolio totals	**78**	**-$8.1**	**-$10.3**	**$2.2**

Source: GAO analysis of DOD data. | GAO-15-342SP

Note: Some numbers may not sum up due to rounding.

To determine actual 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 adding quantities. While a cost increase, it does not indicate acquisition problems. If a program has a cost increase without adding quantities, problems could be at play. Alternatively, a program that has no cost increases but does have quantity reductions may have problems whose financial impacts are offset by the reduced quantities.

Based on our analysis, a total of 40 programs lost buying power in the past year with actual procurement cost increases of $8.7 billion. By our calculations, the net result of quantity changes on these programs should have resulted in a $9 billion cost decrease due to reductions in quantities on 11 of these 40 programs. This means that procurement cost increases not related to quantity changes generated $17.7 billion in additional costs and a net buying power loss. Contributing to this were 26 programs that lost buying power because their procurement costs increased with no change in quantities, an indication of inefficiencies within these programs. For example, F-35 lost buying power because it experienced a procurement cost increase of $4.7

billion over the past year with no change in its planned procurement quantity. Three other programs increased their planned procurement quantities but incurred a higher than expected procurement cost increase, indicating that they lost efficiencies elsewhere.

The remaining 11 programs reported decreasing their quantities; however the cost reductions on these programs are less than expected by our calculations. For example, the Littoral Combat Ship program reduced its quantities by 20 ships since our last assessment and reported a procurement cost decrease of more than $8.6 billion. Yet, almost $2 billion in cost reductions calculated for this quantity decrease were not realized due to inefficiencies in other areas of the program's execution.

Our analysis also shows that 34 programs increased their buying power in the past year and reduced procurement costs by a total of $16.7 billion. Program efficiencies were responsible for more than $15 billion of this cost decrease. Twenty-one of these programs decreased procurement costs with no change in their procurement quantity indicating that they found efficiencies elsewhere. Ten other programs are buying additional quantities at lower prices. In other words, quantities have increased but the corresponding procurement cost increase has been offset by other efficiencies. For example, the Evolved Expendable Launch Vehicle program added 11 launches since our last assessment while at the same time reporting a procurement cost decrease of almost $3 billion. Our analysis indicates that if only the quantity increase is considered, the program's procurement costs should have risen by $4.5 billion. Instead, the program realized a buying power gain of almost $7.5 billion, due primarily to the successful negotiation of a firm-fixed-price, multi-year procurement contract for future services. The final three programs—WIN-T Increment 3, Tactical Tomahawk, and Global Broadcast Service—decreased their quantities and reduced their costs by $1.1 billion more than expected from the quantity reductions alone.

Compared with prior assessments, we found that fewer programs improved their buying power this year than in the recent past. This reverses some of the buying power gains previously realized by the portfolio. In 2013 and 2014 we reported that 60 and 64 percent of programs, respectively, gained buying power. In contrast, 44 percent of the programs in our current assessment did so. On an individual program level, a handful of programs over the past few years have experienced steady gains or losses in buying power:

- Four programs—Tactical Tomahawk, MQ-4C Triton Unmanned Aircraft System, C-5 Reliability Enhancement and Re-engineering Program, and MH-60S Fleet Combat Support Helicopter—experienced gains in buying power each year over the past four years primarily due to recurring procurement cost decreases with no quantity changes.
- Five programs—CH-53K Heavy Lift Replacement Helicopter, DDG 1000 Zumwalt Class Destroyer, Guided Multiple Launch Rocket System, Joint Precision Approach and Landing System, and Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios—lost buying power in each of the past four years. These programs generally had successive years of procurement cost increases with only minimal quantity changes that were outweighed by other inefficiencies.
- One program—B-2 Extremely High Frequency Satellite Communications Increment 1—showed little to no change in procurement cost and quantity each year over the past four years leaving its buying power effectively unchanged.

It is more common for programs to have alternating changes in buying power rather than a consistent trend year after year. For example, last year we reported that Evolved Expendable Launch Vehicle saw the most significant buying power loss with $6 billion of its cost increases not attributable to quantity increases.

6. **The average delay in the delivery of initial capability for programs in the 2014 portfolio grew by more than one month over the past year; the majority of this delay can be attributed to schedule slips of 6 months or more on 11 programs.** Delays to the initial operational capability of systems within the portfolio have been a consistent theme in this annual report since at least 2006. As with cost, the 1.4 month schedule increase for 2014 is the net result of changes reported by all the programs in the current portfolio.

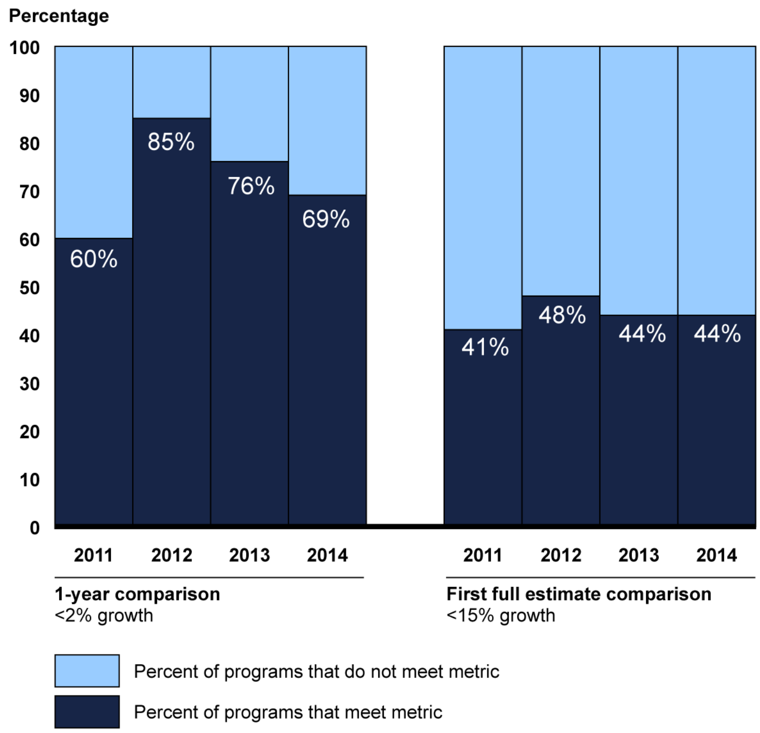
   Our analysis shows that 16 programs reported schedule delays over the past year; with 4 programs reporting a delay of 10 months or more since our last assessment. For example, due to challenges in software development, the Army's Integrated Air and Missile Defense program reported a delay to the delivery of initial capability of 21 months over the past year with its total delay now at 22 months from first full estimate. In another case, the Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios program reported a delay of 10 months over the past year to allow for further competition, the latest in a series of delays, which has pushed the program's delivery of operational capability out by a total of 15 months. Similarly, the MQ-4C Triton reported a delay of 11 months over the past year due to issues with development and testing, resulting in a total delay of more than 2 years. Interestingly, MQ-4C Triton completed 3 years of development and conducted a critical design review before reporting any delays.

Another 7 of the 16 programs reported a schedule delay of 6 months over the past year, enough to qualify as a breach to their current acquisition baseline. In some cases these delays were on top of previous delays**.** For example, the Remote Minehunting System program has been delayed by 6 months in the past year but delivery of initial capability had previously been delayed by more than 7 years. The remaining 5 of the 16 programs experiencing schedule delays each reported a delay of less than 6 months.

7. **As measured against metrics discussed by GAO, the Office of Management and Budget (OMB), and DOD in 2008, 69 percent of programs in the current portfolio meet the metric for less than 2 percent cost growth over the past year, and less than half of all programs meet the goal for less than 15 percent cost growth from first full estimates. Both percentages are lower than those reported in prior assessments.** In December 2008, GAO, OMB, and DOD discussed 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 time periods: the preceding 1-year period, the preceding 5 years, and since first full estimates were established.[11] We were not able to calculate the 5-year metric for this assessment as equivalent data for this period does not exist. We have reported on these outcomes since 2012 and Figure 4 shows how the performance of the current portfolio compares to our prior assessments.

[11]DOD no longer supports the use of these metrics. We continue to believe that they have value.

Figure 4: Comparison of the Cost Performance of DOD's 2011, 2012, 2013, and 2014 Portfolios



Source: GAO analysis of DOD data. | GAO-15-342SP

Note: No 5-year cost performance comparison is shown above because this comparison is not possible for the 2014 portfolio as there were no December 2008 Selected Acquisition Reports issued.

Sixty-nine percent of programs in the 2014 portfolio meet the 1-year cost performance metric by limiting total acquisition cost growth to less than 2 percent and 44 percent of programs meet the threshold for less than 15 percent cost growth since first full estimates. A smaller share of programs are meeting the 1-year metric than in our prior two assessments, but the current portfolio's performance is better than what was observed in the 2011 portfolio, when we first reported on this metric. In contrast, performance against the first full estimate cost growth threshold is relatively unchanged from our prior assessments, remaining less than 50 percent.

We also conducted this analysis on development cost change over the past year and since first full estimates, and found a similar trend in the share of programs that meet the 1-year and since first full estimate cost thresholds from 2011 through 2014.

8. **Many of the programs that report development cost increases of 2 percent or more over the past year are already in production, a point in the acquisition life-cycle where significant changes to development costs should be minimized if a knowledge-based acquisition approach is followed.** In our review of development cost changes made on programs in the current portfolio over the past year, we found that 23 programs report development cost increases of 2 percent or more, and that 18 of them were already in production, a phase of the acquisition cycle which should have minimal development cost growth. On average, these 18 programs are more than 11 years old and over 60 percent of them have already achieved their initial operating capability. Table 4 shows the extent and causes of the development cost growth on some of these programs.

Table 4: Programs in Production with the Largest Development Cost Increases over the Past Year

Fiscal year 2015 dollars (in millions)

Program	Percentage increase in development cost over the past year	Amount of development cost growth over the past year	Initial capability achieved	Primary cause for development cost increase
AIM-9X Block II Air-to-Air Missile	65%	$148	No	Deficiency
MQ-8 Fire Scout	25	180	Yes	New capability
Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios	10	130	Yes	Deficiency
E-2D Advanced Hawkeye Aircraft	9	497	Yes	New capability
Ground/Air Task Oriented Radar	8	78	No	Deficiency
Tactical Tomahawk RGM-109E/UGM 109E Missile	8	58	Yes	Modernization
EA-18G Growler Aircraft	7	157	Yes	New capability
AGM-88E Advanced Anti-Radiation Guided Missile	7	57	Yes	Software update
Guided Multiple Launch Rocket System	7	69	Yes	New capability
LHA 6 America Class Amphibious Assault Ship	6	24	No	New capability
AIM-120 Advanced Medium Range Air-to-Air Missile	5	216	Yes	New capability
Global Positioning System III	5	147	N/A	Deficiency
M109A7 Family of Vehicles	5	55	No	Deficiency

Source: GAO analysis of DOD data. | GAO-15-342SP

Development cost increases on these programs are generally due to one of two factors. The first factor is the incremental addition of unplanned capability to a program's baseline without accounting for the cost of this added capability. For example, the MQ-8 Fire Scout reported a development cost increase of 25 percent due in part to the addition of new system capabilities more than 14 years after it began system development in January 2000. The second factor is the need for additional funding to correct deficiencies found late in testing. For example, the AIM-9X Block II program reported a 65 percent increase in development cost due to deficiencies found during operational testing. These cost increases indicate that the programs may not have demonstrated high levels of knowledge before the commitment of resources at system development start or critical design review.

9. **If the cost and schedule performance data of the F-35 is removed, the 2014 portfolio's performance improves.** Since joining the portfolio in 2001, F-35 has been the costliest program in the portfolio while also experiencing approximately $113 billion in cost growth, more than any other program in the current portfolio. The program has also experienced a significant loss in buying power as this cost growth occurred despite quantities dropping by more than 400 aircraft since the start of system development.

   When looking at total cost, the F-35 currently accounts for almost one-quarter, or more than $335 billion, of the total estimated development and procurement cost of the portfolio. In addition, among the 78 programs in the current portfolio, it has the largest amount of funding remaining for development and procurement. As we have previously concluded, there are risks facing the program which may result in additional cost growth and schedule delays.[12] With the first of three separate initial operational capability events scheduled to take place in July 2015 and the procurement of aircraft planned for the next two decades or more, the F-35 will likely continue to significantly affect the portfolio's performance.

   We calculated the 2014 portfolio's performance over the past year without data from the F-35 and found that the portfolio's performance

[12]GAO, *F-35 Sustainment: Need for Affordable Strategy, Greater Attention to Risks, and Improved Cost Estimates*, GAO-14-778 (Washington, D.C.: Sep 23, 2014). See also the program assessment in this report.

improves. Without the cost growth over the past year on this program, the acquisition cost change reported by the portfolio would have decreased an additional $4.3 billion, for a total decrease of $11.9 billion instead of the $7.6 billion discussed earlier that includes the F-35 program data. Exclusion of the delay in delivery of operational capability on this one program reduces that calculated for the other 77 programs by less than one month to 28.4 months on average.

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

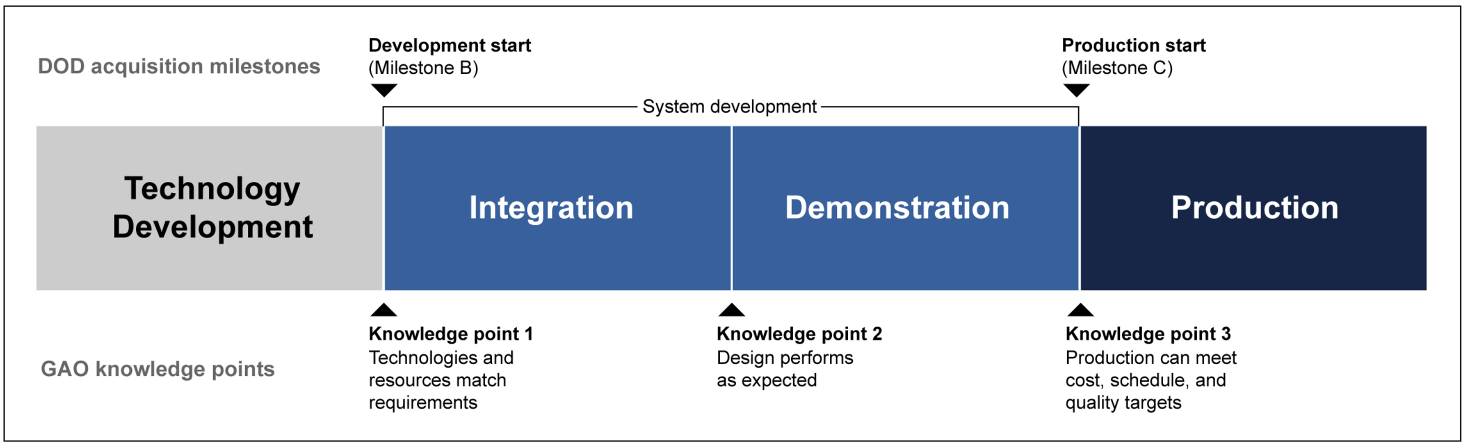
Our current assessment shows that while DOD follows some knowledge-based approaches to reduce risk, it has room for improvement. While programs that have recently passed through major decision points have demonstrated best practices—such as constraining development times—key practices like demonstrating technology readiness or controlling manufacturing processes are not being fully implemented. As a result, many programs will carry risk into subsequent phases of acquisition that could result in cost growth or schedule delays.

Our prior 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 before significant commitments are made. In essence, knowledge supplants risk over time. In our past work examining weapon acquisition and best practices for product development, we have found that leading commercial firms and successful DOD programs pursue an acquisition approach that is anchored in knowledge, whereby high levels of product knowledge are demonstrated at critical points in the acquisition process. This work led to multiple recommendations that DOD generally or partially agreed with and has made progress in implementing.[13] On the basis of this work, we have

[13]GAO, *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, GAO/NSIAD-99-162 (Washington, D.C.: July 30, 1999); *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: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes*, GAO-02-701 (Washington, D.C.: July 15, 2002); *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: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding*, GAO-09-322 (Washington, D.C.: May 13, 2009); and *Best Practices: DOD Can Achieve Better Outcomes by Standardizing the Way Manufacturing Risks Are Managed*, GAO-10-439 (Washington, D.C.: Apr. 22, 2010).

identified three key knowledge points during the acquisition cycle—development start, the system-level critical design review, and production start—at which programs need to demonstrate critical levels of knowledge to proceed. Figure 5 aligns the acquisition milestones described in DOD's primary acquisition policy with these knowledge points. In this report, we refer to DOD's engineering and manufacturing development phase as system development. Production start typically refers to a program's entry into low-rate initial production.

Figure 5: DOD's Acquisition Cycle and GAO Knowledge Points



Source: GAO. | GAO-15-342SP

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 have been demonstrated to work in their intended 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 to 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 system prototypes and successfully demonstrated in an operational environment before a contract is awarded for the detailed 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, as well as the three-dimensional product model by the start of construction for a new ship. Programs can also improve the stability of their design 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 postproduction 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 build 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 best to move into subsequent acquisition phases that commit more budgetary resources. Demonstrating technology maturity is a prerequisite for moving forward into system development, during which 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 38 current programs, which are mostly in development or early production.[14] 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 15 future major defense acquisition programs, as identified by DOD, expect to attain when they start system development in the coming years.[15]

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

[14]Because knowledge points and best practices differ for shipbuilding programs, we exclude the 5 shipbuilding programs from parts of our analysis at each of the three knowledge points, for more information see appendix I.

[15]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" section of appendix I for more information.

Knowledge Point Observations

1. Six programs began system development in 2014 and none of them implemented all four of the knowledge-based practices for development start. One program reported demonstrating all of its critical technologies in an operational environment and two completed all recommended systems engineering reviews, such as system functional and preliminary design reviews. None of the six completed both of these key practices. All six programs plan to constrain their system development phase. The implementation of knowledge-based practices by these six programs differs little from what we observed on programs that reached this point in the past.
2. Two programs, the Enhanced Polar Satellite and Ship to Shore Connector, held critical design reviews in 2014 and neither of them implemented all the knowledge-based practices we recommend. While the satellite program is a software development effort with no remaining hardware design work, Ship to Shore Connector is a hardware dominant program that did not release the recommended 90 percent of planned design drawings to demonstrate design stability. One of the two tested an early system-level prototype, and each utilized other activities at their design review to increase the confidence in their product's design stability. The implementation of knowledge-based practices by these programs shows no improvement over other programs that are beyond this point.
3. None of the 38 current programs we assessed made a production start decision over the past year, although three programs were scheduled to do so. None of these three programs fully demonstrated knowledge-based practices at earlier junctures and were not likely to do so by their scheduled production decisions, making such delays more likely. For the other programs we assessed, implementation of knowledge-based practices at this decision point was mixed, leaving their future cost and schedule objectives at risk.

Additional details about these observations follow.

1. **The six programs that started system development in 2014 are at risk for adverse cost and schedule outcomes due to early knowledge deficits. One of the six programs fully demonstrated its critical technologies, and two conducted all systems engineering reviews, including a preliminary design review, before entering system development. No program did both.** 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.[16] Figure 6 shows the extent to which recommended acquisition practices for knowledge point 1 have been implemented for the six programs that recently started system development—Armored Multi-Purpose Vehicle (AMPV), Combat Rescue Helicopter (CRH), Enhanced Polar System (EPS), Space Fence, Three-Dimensional Expeditionary Long-Range Radar (3DELRR), and VH-92A Presidential Helicopter Replacement—as well as the other 32 current programs we assessed.

Figure 6: Implementation of Knowledge-Based Practices for Programs in System Development

Knowledge-based practices at development start	AMPV	CRH	EPS	Space Fence	3DELRR	VH-92A	Other 32 programs ●	Other 32 programs ○	Other 32 programs ––
Demonstrate all critical technologies in a relevant environment	●	––	●	●	●	●	16	8	8
Demonstrate all critical technologies in an operational environment	●	––	––	○	○	○	3	19	10
Complete system functional review and system requirements review before development start	○	○	○	●	●	○	10	20	2
Complete preliminary design review before development start	○	○	●	●	●	○	11	19	2
Constrain development phase to 6 years or less	●	●	●	●	●	●	20	5	7

● Practice implemented

○ Practice not implemented

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

Source: GAO analysis of DOD data. | GAO-15-342SP

Note: EPS is Enhanced Polar System, CRH is Combat Rescue Helicopter, 3DELRR is Three-Dimensional Expeditionary Long-Range Radar, and AMPV is Armored Multi-Purpose Vehicle.

[16]GAO, *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, GAO/NSIAD-99-162 (Washington, D.C.: July 30, 1999) and 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).

Knowledge-based acquisition practices recommend that programs fully mature technologies and demonstrate them in an operational environment prior to starting system development. This is a higher level of technology maturity than currently required at system development start, as federal statute provides that technology should be demonstrated only in a relevant environment.[17] 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.

We found that only one of the programs starting system development in 2014—the AMPV—satisfied this best practice. DOD assessed the AMPV's critical technologies as fully mature based on a technology readiness assessment conducted in October 2014, and the program office stated that no further technology development or design innovations are currently planned. EPS is a space-based system where demonstrating technology in an operational environment is considered not applicable by our best practices. Satellite technologies are considered fully mature after demonstrations in a relevant environment due to the difficulty of demonstrating technology maturity in an operational environment—on orbit in outer space. According to EPS program officials, the program demonstrated its technologies to the maximum extent practical, as it relies on technologies from other satellite programs, and conducted prototype and other tests for those technologies unique to EPS.

Three programs—3DELRR, Space Fence, and VH-92A—entered system development with their critical technologies demonstrated in a relevant environment, but short of the best practice of demonstrating their critical technologies in an operational environment. The requirement for demonstrations in a relevant environment was waived by DOD for the sixth program—CRH—as DOD officials concluded that the technologies needed for this program were sufficiently mature and fielded on other weapon systems. This determination relies on a

[17]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 system 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).

technology assessment completed in 2006 for the Combat Search and Rescue Replacement Vehicle, a predecessor program that was cancelled. As a follow-up to the technology readiness waiver, the program will conduct a technology readiness assessment in the summer of 2015.

Of the remaining 32 programs we assessed, three reported that all of their critical technologies were matured to best practice standards when they began system development, while 13 programs reported having all critical technologies nearing maturity prior to system development. Another eight programs reported critical technologies as immature. Our analysis shows these 8 began system development more than 5 years ago and have experienced on average a much higher rate of development cost growth than the other programs we assessed. The remaining programs reported no information on technology maturity or became a major defense acquisition program after the start of system development.

Knowledge-based acquisition practices recommend that programs hold systems engineering events, such as 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. The Weapon Systems Acquisition Reform Act of 2009 (WSARA) established a legislative requirement to conduct a preliminary design review prior to entering system development.[18] Among the 6 programs that started system development in 2014, 3 of them conducted this review before reaching this point. The other 3 programs received a waiver to this requirement and expect to conduct this review after their system development start with each of them planning to base their system on existing designs and technologies.

Eleven of the other 32 programs we assessed held a preliminary design review before the start of system development. Our analysis of the timing of this review shows that implementation of this practice did

[18]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).

improve after the implementation of WSARA. For example, among the 10 programs that began system development since 2009, we found that six of them held a preliminary design review before the start of system development. In contrast, among the 22 programs that began system development before WSARA or reported that they started at production, five reported holding a preliminary design review before their system development start. However, a number of programs have recently received a waiver to this requirement, including 3 of 6 programs in 2014, and others, such as the Navy's Air and Missile Defense Radar in 2013 and the KC-46 Tanker Modernization Program in 2011.

In addition to the preliminary design review, knowledge-based acquisition practices recommend the completion of two additional early systems engineering reviews—a system requirements review to ensure that requirements have been properly identified to help ensure mutual understanding between the government and contractor, and a system functional review to establish a baseline for the planned system. Two programs—Space Fence and 3DELRR—completed these reviews prior to starting system development. The other four programs did not conduct these reviews, or held only one of the two, before their system development start. This closely aligns with the rate of implementation that we saw on the other 32 programs we assessed. Six held all of these systems engineering reviews before system development start, and a total of 13 have held none of the three early system engineering reviews before starting system development.

Knowledge-based acquisition practices also recommend that a program constrain the system development phase to six years or less. Our review of the six programs that began system development over the past year found that each of them currently plan to do so. For the remaining 32 programs we assessed, 20 planned to limit their system development phase to six years or less at the time they started system development.[19] Plans to constrain the development phase at the start of system development are not always successful, as 6 of these 20 programs later experienced delays that extended their system development beyond initial estimates. As a group, they reported

[19]We did not assess shipbuilding programs against this recommended practice to limit the development phase, as their development cycles do not align in a manner consistent with other programs.

approximately 12 percent development cost growth from first full estimates. As several of the other 14 programs plan to make a production start decision in the future, additional delays may occur, especially as a number of these programs have not implemented the best practices that facilitate the successful completion of development.

As part of our analysis, we also assessed 15 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. Seven identified critical technologies and their anticipated maturity levels expected at system development start and one future program—the Unmanned Carrier-Launched Airborne Surveillance and Strike system—reported that it expects its critical technologies to be fully mature. The other six future programs reported that their critical technologies are expected to be nearing maturity at the time of their system development start.

Similar to those programs that held system development start in the past year, 8 of the 15 future programs plan to hold a preliminary design review before the start of system development and seven of them also plan to conduct both a system functional and system requirements review before that time. While 10 of the 15 future programs currently plan to limit their system development phase to 6 years or less, these plans are at risk as none of the programs plan to satisfy all the knowledge-based practices we reviewed, leaving them at risk for cost and schedule growth.

DOD's decision to let these programs proceed without the knowledge required to achieve a requirements and resource match has larger implications than the expected outcomes on these programs. It sends a signal across the entire portfolio of current and future programs about what is acceptable in terms of following a knowledge-based acquisition approach. It is imperative that top decision-makers ensure that new programs exhibit desirable principles that embody knowledge-based acquisition best practices before they are approved and funded at the start of system development, one of the key points in the acquisition cycle where discipline and accountability can be established and reinforced.

2. **Two of the 38 current programs we assessed—the Enhanced Polar Satellite and Ship to Shore Connector (SSC)—held critical**

design reviews in 2014 and neither implemented all of the knowledge-based acquisition practices we recommend. While the satellite program is a software development effort with no remaining hardware design work, SSC is a hardware dominant program that did not release the recommended 90 percent of planned design drawings to demonstrate design stability. One of the two tested an early system-level prototype, and each utilized some of the other knowledge-based practices at their design review to increase the confidence in their product's design stability, such as beginning to plan and test for reliability growth and assessing the effects of the design on production. Just as programs that enter system development with immature technologies cost more and take longer to deliver their operational capabilities to the warfighter, our body of work in this area has shown that programs that hold their critical design review before achieving a stable, demonstrated design also experience higher average costs and longer schedule delays. Figure 7 outlines the implementation of these, as well as other, best practices among the programs we assessed.

Figure 7: Implementation of Knowledge-Based Practices for Programs at their Critical Design Review

Knowledge-based practices at critical design review	EPS	SSC	Other 27 programs: ●	Other 27 programs: ○	Other 27 programs: ——
Demonstrate all critical technologies in an operational environment	——	●	3	17	7
Release at least 90 percent of drawings or 100 percent of 3D zones	——	○	6	14	7
Test a system-level integrated prototype	●	○	2	18	7
Establish a reliability growth curve	●	●	17	5	5
Identify key product characterisitics	●	●	24	0	3
Identify critical manufacturing processes	——	●	19	2	6
Conduct producibility assessments to identify manufacturing risks for key technologies	——	●	20	2	5
Complete failure modes and effects analysis	●	○	21	1	5

● Practice implemented

○ Practice not implemented

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

Source: GAO analysis of DOD data. | GAO-15-342SP

Note: EPS is Enhanced Polar Satellite and SSC is Ship to Shore Connector.

EPS began system development in April 2014 and conducted its design review approximately 3 months later, while the SSC held its design review approximately 2 years after its system development start. Yet, neither of the programs demonstrated that their designs were mature by releasing at least 90 percent of the expected design drawings. According to the EPS program office, this practice was not applicable at the system-level critical design review, however earlier design reviews for the individual program segments that assessed the hardware did include the release of mature designs. EPS officials also stated that an analogous design standard was applied to the software development effort to ensure its completeness. The SSC program released approximately 80 percent of its expected engineering drawings prior to design review, short of the 90 percent completion level recommended by best practices. Of the remaining 27 programs we assessed that held their critical design review prior to 2014, six programs released at least 90 percent of their total expected design drawings before holding this review. None of the shipbuilding programs we assessed met the best practice of completing 100 percent of their three-dimensional design models prior to the start of fabrication.

The use of early system prototypes during system development is another recommended practice for demonstrating that a system has a stable design, will work as intended, and can be built within cost and schedule estimates. While the three segments of the EPS program are at separate stages of development, the program completed extensive risk reduction activities with early system prototypes consisting of flight equivalent payloads, a gateway engineering development model, and prototype control and planning software. The SSC program did not conduct testing of a system-level integrated prototype and currently plans to conduct this testing in October 2015, about a year after its design review and several months after the program's decision to start production.

We assessed 27 other programs that held a critical design review prior to 2014, and found that 20 tested or plan to test an early integrated prototype, and two of these programs did so before their critical design review. For the other 18 programs, early integrated prototype testing occurred or will occur well after the critical design review with a gap of 2 years or more on many of these programs. We did not assess shipbuilding programs against this knowledge-based acquisition practice as testing early system prototypes in these programs may not be practical. The limited use of this testing before design review among the programs we assessed shows no improvement from our prior assessments.

The programs we assessed also reported the use of other knowledge-based practices to increase confidence in the stability of their product's design and its effect on production. Both the EPS and SSC programs reported establishing a reliability growth curve to track if the system's reliability is being demonstrated as planned. The satellite program reported two other activities as applicable and completed, while the SSC program reported that they completed 3 of the 4 remaining key practices. For the other 27 programs we assessed, over half of them reported using all five of these key practices and many of those that did not still reported using a majority of them (3 or 4 out of 5).

3. **None of the 38 current programs we assessed made a production start decision in the past year. The three programs scheduled to do so each delayed this decision past our review date of January 2015. For the 13 programs we assessed that began production in prior years, implementation of the knowledge-based practices we assessed at this decision point was mixed.** According to the schedule estimates provided in our last assessment, three programs—MQ-4C Triton Unmanned Aircraft System, SSC, and Small Diameter Bomb Increment II (SDB II)—planned to make a production decision in 2014. Each of them deferred this decision point beyond the period of our review. These delays are not surprising as the three programs that deferred their production start decision did not implement a number of knowledge-based practices at their system development start or critical design review, as shown in figure 8 below.

Figure 8: Implementation of Key Knowledge-Based Practices at System Development Start and Critical Design Review for Three Programs that Delayed their Production Start Decision

Knowledge-based practices at system development start	**MQ-4C Triton**	**SDB II**	**SSC**
Demonstrate all critical technologies in a relevant environment	●	●	●
Demonstrate all critical technologies in an operational environment	○	○	●
Completed preliminary design review before system development start	○	●	●
Knowledge-based practices at critical design review			
Release at least 90 percent of drawings or 100 percent of 3D zones	○	●	○
Test an early system-level integrated prototype	○	○	○

● Practice implemented

○ Practice not implemented

Source: GAO analysis of DOD data. | GAO-15-342SP

Note: SDB II is Small Diameter Bomb II and SSC is Ship to Shore Connector.

For example, the MQ-4C Triton began system development in 2008 before its critical technologies were demonstrated in an operational environment, before it held a preliminary design review in 2010, and before it completed other early systems engineering reviews. Similarly, the MQ-4C Triton held its critical design review in 2011 before it released 90 percent of the expected design drawings or demonstrated its capabilities by testing an early integrated prototype. The SDB Inc. II program entered system development in July 2010 and proceeded to its critical design review the next year, all before demonstrating its critical technologies in an operational environment. It also held its critical design review before demonstrating the system's design with an early integrated prototype. At the time of our review, these programs reported that they had not yet implemented knowledge-based best practices for production start. For example, none of the three had demonstrated that their manufacturing processes were in control and two programs had not yet demonstrated a production-representative prototype in its intended environment.

While none of the 38 current programs we assessed made a production decision since our last assessment, 13 of them have made this decision in prior years and each began production with a knowledge deficit. This condition left decision-makers with less information than knowledge-based practices recommend before committing to production. For example, two programs currently in production did not demonstrate technology maturity or release 90 percent of their drawings to achieve design stability before beginning production. Figure 9 shows the extent to which programs that held a production decision implemented best practices at this juncture.

Figure 9: Implementation of Knowledge-Based Practices by Programs at their Production Decision

Knowledge-based practices at production start	Totals for the 13 programs assessed: ●	○	——
Demonstrate all critical technologies in an operational environment	8	4	1
Release at least 90 percent of drawings	8	2	3
Demonstrate manufacturing process capabilities are in control	1	8	4
Demonstrate critical processes on a pilot production line	8	3	2
Test a production-representative prototype in its intended environment	6	6	1

● Practice implemented

○ Practice not implemented

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

Source: GAO analysis of DOD data. | GAO-15-342SP

We found that one of the 13 programs we assessed at this knowledge point provided data indicating that their critical manufacturing processes were in control at the start of production. Our prior work has shown that capturing critical manufacturing knowledge before entering production helps ensure that a weapon system will work as intended and can be manufactured efficiently to meet cost, schedule, and quality targets as it reduces the potential for defects, and is generally less costly than performing extensive inspections after an item is built.

Another best practice to ensure the maturity of manufacturing processes is to demonstrate them on a pilot production line before the decision to enter production is made. Among the 13 programs we assessed that are currently in production, 8 demonstrated their manufacturing processes on a pilot production line. Of the 17 programs we assessed that plan to make a production decision in the future, 12 indicated that they intend to test manufacturing activities on a pilot production line before they reach this juncture.

Our body of work on a knowledge-based approach shows that production and postproduction 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. Six of the 13 programs we assessed reported testing a production-representative prototype before this decision. Similarly, 12 of the 17 programs we assessed that plan to hold their production decision in the future intend to test a fully configured prototype first. Two programs reported that they currently plan to conduct this testing after the production decision is made. The remaining three programs reported that the date for this fully configured prototype testing has not been determined or is not applicable. In not testing such prototypes prior to production, these programs risk discovering issues late in testing, triggering the need for expensive re-tooling of production lines and retrofitting of articles that have completed production.

Observations about DOD's Implementation of Key Acquisition Reform Initiatives and Program Concurrency

More DOD programs are implementing acquisition reform initiatives now than over the past five years, which should lead to better acquisition outcomes. While real progress has been made, DOD still faces challenges in fully implementing these reforms. The sheer size and importance of the investment in the acquisition of weapon systems warrants continued attention to reform initiatives. Congress and DOD have made legislative and policy changes to improve the way the department procures weapon systems and to address the symptoms of a dysfunctional acquisition system that resulted in frequent cost overruns and delays in the delivery of operational capabilities. The enactment of WSARA by Congress in 2009 and DOD's interim revision of Instruction 5000.02 in November 2013, which incorporated its "Better Buying Power" initiative memorandums, represent efforts to improve this system.[20]

We focused our analysis on the aspects of DOD's "Better Buying Power" initiatives and WSARA that addressed program and portfolio affordability, controlling cost growth, and promoting competition throughout the acquisition life-cycle, as well as other reforms.[21] In addition, we reviewed programs' software development efforts—an often critical component of

[20]Pub. L. No. 111-23. Interim Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System* (Nov. 25 2013). A finalized version of this instruction was released in January 2015, after our audit cutoff date.

weapon system development—to determine how programs monitor and manage risk and at what point they complete software development. Finally, we assessed the amount of concurrency between developmental testing and production planned for current programs.[22]

Overall, we found a slight improvement from past assessments in the number of programs implementing these reforms including increased affordability and "should-cost" analyses, encouraging competition, and conducting configuration steering boards. Despite this progress, other risks persist in the programs we assessed. We found that several programs, which require significant funding commitments to deliver important capabilities to the warfighter, have received waivers from activities that could help to ensure the success of the program and put new programs on a less risky path. In addition, we found concurrency between development and production on a number of programs. Our analysis allows us to make the following seven observations concerning key acquisition reform initiatives and program concurrency.

[21]Ibid.

[22]Information for the 38 current programs and 15 future programs was collected from two data collection instruments distributed to program officials. See the "Analysis of Acquisition Initiatives and Program Concurrency" section of appendix I for more information.

Acquisition Reform and Concurrency Observations

1. Thirty-five of the 53 current and future programs we assessed have established an affordability constraint, an improvement from our last assessment, and all but one of these programs reported they are on track to remain within their constraints.
2. Thirty-four of the 38 current programs we assessed have conducted a “should-cost” analysis resulting in anticipated savings of $32.3 billion; over half of which has been realized.
3. While 49 of the 53 current and future programs we assessed do have acquisition strategies that include some measures to encourage competition, less than half of the 15 future programs plan to conduct competitive prototyping before system development start.
4. All but 2 of the 38 current programs we assessed conducted a configuration steering board, with 25 programs reporting that this review occurred during the past year. Nine programs reported that changes were approved at their last review.
5. Eighteen of the 38 current programs we assessed have held a milestone B since 2009. Ten of these programs were granted a total of 19 different waivers to selected components of mandatory program certifications required at this point. DOD most frequently waived components of the certifications related to ensuring full funding availability for product development and completion of preliminary design review prior to milestone B.
6. Twenty-five of the 38 current programs we assessed reported software development as a high-risk area. Of these, 19 programs plan to begin production prior to completing the software development for integration with system hardware and achieving baseline capabilities.
7. Eleven of the 15 current programs we assessed, that have started production, plan to perform 30 percent or more of their developmental testing during production despite the increased risk of design changes and costly retrofits. Five of these programs expect to place more than 20 percent of their procurement quantities under contract before developmental testing is completed.

Additional details about each observation follow.

1. **Thirty-five of the 53 current and future programs we assessed have established an affordability constraint, an improvement from our last assessment, and all but one of these programs reported that they are on track to remain within their constraints.** In 2010, DOD launched a series of “Better Buying Power” initiatives with the goal of delivering better value to the taxpayer and warfighter by improving the way it does business in the department. One such initiative was the establishment of an affordability analysis that results in cost constraints. This analysis differs from program cost estimates in that the constraint serves as a key program requirement to ensure that

the program remains cost-effective.[23] In accordance with the Interim 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. Sixty-eight percent of the current programs we assessed, or 26 of 38, have established an affordability requirement—a better rate of implementation than the 54 percent reported in our last assessment. All of these programs, with the exception of the Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios, responded that they currently expect to meet their affordability requirement. Most of the 12 programs that have not established an affordability requirement either plan to establish one in the future or began system development before this requirement was put in place.[24]

Similarly, 9 of the 15 future programs report that they established an affordability goal, also a slight improvement over our last assessment. Most of the remaining six programs that have not established an affordability constraint report that they plan to establish one before their system development start. While the effectiveness of these cost constraints has yet to be widely tested they demonstrate the commitment of DOD leadership in controlling costs and could be effective if programs are held accountable if they do not meet these cost constraints.

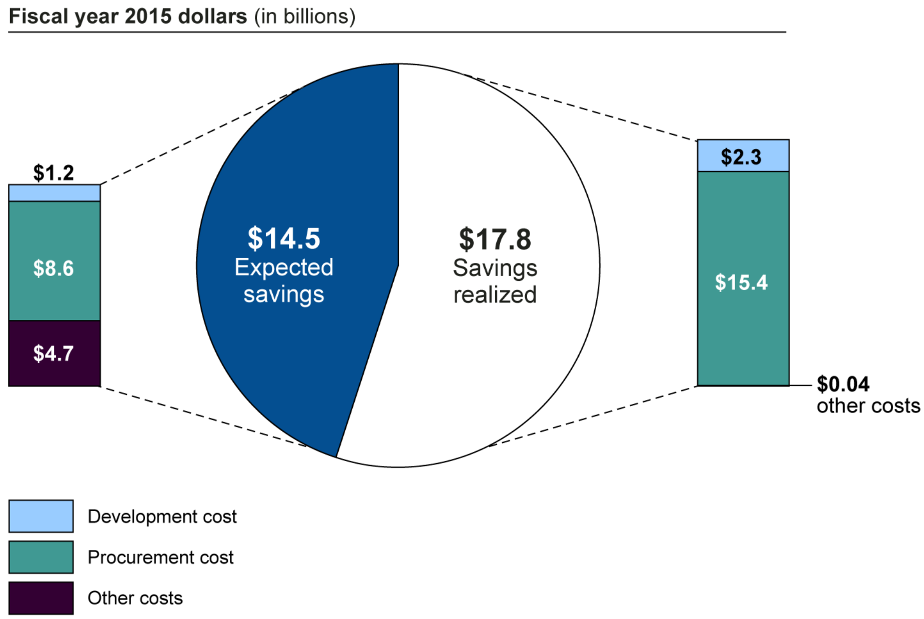
2. **Thirty-four of the 38 current programs we assessed have conducted a "should-cost" analysis resulting in anticipated savings of $32.3 billion; over half of which has been realized.** DOD's "Better Buying Power" initiatives also emphasize the

[23]Affordability goals are established at milestone A, the entry into technology development. After systems engineering trade-offs are completed during the technology development phase, these affordability goals then become affordability caps prior to milestone B, the start of system development, when a match is to be made between requirements and resources. We refer to the goals and caps collectively as affordability constraints.

[24]The Gerald R. Ford Class Nuclear Aircraft Carrier program has a congressionally mandated cost cap which we do not consider the same as the affordability requirement considered in this analysis. As a result we include this program in the total number of programs without an affordability cap.

importance of driving cost improvements during contract negotiation and program execution to control costs both in the short-term and throughout the product life cycle. In accordance with the Interim 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. According to our analysis of questionnaire responses, 34 of 38 current programs we assessed conducted a “should-cost” analysis and identified $32.3 billion in savings as a result. Of the four current programs that reported not conducting a “should-cost” analysis, three are in the process of completing it. The final program, Littoral Combat Ship - Mission Packages, was relieved of this requirement by the milestone decision authority as the program had already made a number of program execution improvements as reflected in the current approved baseline. An accounting of realized and expected savings is shown in figure 10 below.

Figure 10: Realized and Expected "Should-Cost" Savings for 34 Programs



Source: GAO analysis of questionnaire data. | GAO-15-342SP.

Note: Some numbers may not sum up due to rounding.

Twenty-three of the 34 programs that report conducting a "should-cost" analysis claim a total of $17.8 billion in realized savings to date. Two programs account for about 65 percent of the total realized savings reported. The KC-46 Tanker program reports a total savings of $7.3 billion due in part to efficiencies realized in contract negotiations. The EELV program reported $4.4 billion in realized savings due primarily to the negotiation of a firm-fixed-price, multi-year procurement contract for launch services.

The 23 programs cited several activities as responsible for some or all of their "should-cost" savings, including:

- efficiencies realized through contract negotiations (13 programs),
- design trades to balance affordability and capability (10 programs),
- changed capabilities or requirements (eight programs)

- reduced systems engineering or program management overhead (eight programs), and

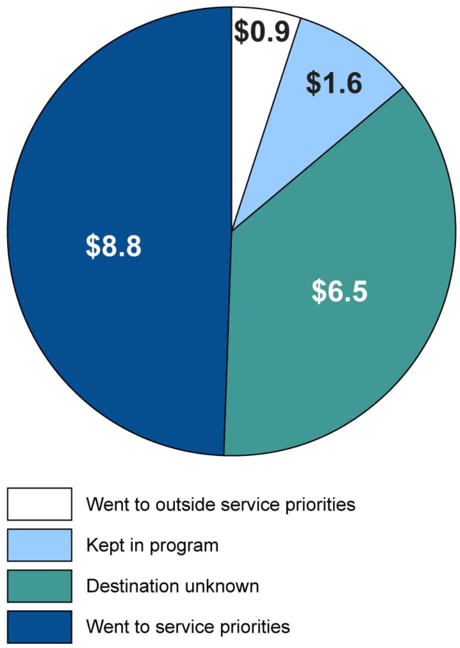
- efficiencies realized in testing (eight programs).

Achieving efficiencies in systems engineering and testing is laudable but should be done with caution to ensure that short-term savings do not come at the expense of long-term needs. Three of the eight programs that reported savings as a result of testing efficiencies also report a substantial amount of concurrency between developmental testing and procurement. Overlaps between these two activities may leave these programs at risk to deficiencies discovered during production that could require costly modifications to systems already built.

The 23 programs with realized “should-cost” savings also provided insight as to how their realized savings were reallocated. Figure 11 below shows the amount of savings reallocated to other purposes.

Figure 11: Priorities for the $17.8 Billion in Realized “Should-Cost” Savings as Reported by 23 Programs We Assessed

Fiscal year 2015 dollars (in billions)



Source: GAO analysis of DOD data. | GAO-15-342SP

Of the approximately $17.8 billion in realized “should-cost” savings, $1.6 billion was kept within the programs to fund other priorities. Of this amount, a reported $227 million was used to offset prior year sequestration reductions.

Approximately 45 percent, or $14.5 billion, of the $32.3 billion in total “should-cost” savings, is expected to be realized in the future. Sixty-one percent of this amount, or $8.8 billion, is attributable to five of the 23 current programs we assessed—Air and Missile Defense Radar, DDG 51, F-35, Gerald R. Ford Class Nuclear Aircraft Carrier, and the VH-92A Presidential Helicopter Replacement.

3. **While 49 of the 53 current and future programs we assessed have acquisition strategies that include some measures to encourage competition, less than half of future programs plan to conduct competitive prototyping before system development start.** Competition is a critical tool for achieving the best return on the

government's investment. Major defense acquisition programs are generally required to plan for the use of competitive prototypes from two or more competing teams before a program starts system development and have acquisition strategies that ensure the option of continuing competition throughout the acquisition life cycle.[25] According to DOD, competition—or at least the fostering of competitive environments—is a central tenet in acquisition reform and is the single best way to motivate contractors to provide the best value.[26] Table 5 shows when programs plan to pursue activities to ensure competition.

Table 5: Use of Activities to Ensure Competition Reported by 53 Future and Current Programs We Assessed

Activity to ensure competition is utilized or expected to be utilized		**For the 15 future programs**	**For the 38 current programs**
Competitive prototyping conducted prior to system development start	Yes	7	16
	No	8	22
Measures to ensure competition after system development start included in program strategy[a]	Yes	15	33
	May not or will not take place	0	5
Programs planning for competition versus those that are taking no actions			
Actions taken to promote competition both prior to and after system development start		7	15
Actions to promote competition taken only prior to the start of system development		0	1
Actions to promote competition will or have taken place only after the start of system development		8	18
No actions taken to promote competition before or after system development start		0	4

Source: GAO analysis of questionnaire data. | GAO-15-342SP

[a]We use program strategy to refer to technology development strategies used by future programs and acquisition strategies used by current programs.

Only 23 of the 53 current and future programs we assessed report conducting or planning to conduct some form of competitive prototyping before starting system development. Sixteen of 38 current programs report conducting competitive prototyping at either a sub-system or a system-level prior to the start of system development. For the other 22 current programs that did not conduct competitive prototyping, a majority of them report that the requirement was not in

[25]Pub. L. No. 111-23, §§ 202, 203.

[26]DOD, *Performance of the Defense Acquisition System*, Acquisition, Technology, and Logistics, June 13, 2014, Washington D.C.

place when they began system development, while five report that the requirement was waived. Just under half, or 7 of the 15 future programs we assessed, plan to conduct competitive prototyping before their system development start which shows little change from what we reported in our last assessment. Six report plans to conduct key subsystem prototype competitions while one is planning a system-level prototype competition. Seven future programs reported that they would seek a waiver for this requirement, primarily justified by the rationale that the cost of producing competitive prototypes exceeds the expected life-cycle benefits. Our prior work has concluded that the use of competitive prototypes can reduce technical risk in major defense acquisition programs.[27] While prototyping may not always be supported by a program's business case, programs not implementing competition when appropriate may miss opportunities to lower costs.

Forty-eight of the 53 current and future programs we assessed, 91 percent, report that their acquisition strategy includes options for competition after system development start and through the completion of production. This is a significant improvement over the 52 percent of programs we reported in our last assessment. Measures in a program's acquisition strategy to ensure competition or the option of competition after a program starts system development may include approaches such as the use of modular, open architectures to enable competition for upgrades or the use of build-to-print approaches to enable production through multiple sources.[28] Among current programs, periodic reviews to address long-term competition, the use of open systems architecture, or the acquisition of complete technical data packages were among the most frequently cited strategies.

All of the future programs we assessed reported that their technology development or acquisition strategies call for measures to ensure competition after development start, again a significant improvement over our prior assessments. As with current programs, periodic

[27]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).

[28]Open systems architecture is a design approach that includes standard interfaces and the use of modular components within a product (like a computer) that can be replaced easily. This allows the product to be refreshed with new, improved components made by a variety of suppliers.

reviews to address long-term competition, the use of open systems architecture, or the acquisition of complete technical data packages were the most likely strategies to increase the possibility of future competition. However a larger percentage of future programs report at least considering the use of open architecture and acquisition of technical data packages. This is significant as we have previously found that use of these strategies can reduce product development time and life-cycle costs, increase competition and innovation, and enable interoperability between systems.[29]

4. **All but two of the 38 current programs we assessed report conducting a recent configuration steering board, with 25 programs reporting that this review occurred during the past year. Nine programs reported that changes were approved at their last review.** According to statute, and as implemented in the Interim DOD Instruction 5000.02, major defense acquisition programs are required to conduct annual configuration steering boards to review proposed changes to requirements or significant technical configuration changes that may impact cost and schedule performance.[30] Thirty-six current programs we assessed report conducting such a review while another two programs report that they had not as they only recently began system development. A majority, 25 of 38 programs, report that this review occurred in the 12 months prior to the submission of our questionnaire. Another three planned to hold a configuration steering board review in September and October of 2014 and the remaining programs have not yet scheduled their next review.

   Nine programs report that changes were approved or recommended for further consideration at their review. Two of these 9 changes were options to reduce program cost or moderate requirements, referred to as "descoping". For example, the Warfighter Information Network-Tactical Increment 3 program reported that as a result of descoping it would cease development of certain capabilities for communications and instead focus on network operations and completion of the software development efforts.

[29]GAO, *Defense Acquisitions: Review of Private Industry and Department of Defense Open Systems Experiences*, GAO-14-617R (Washington, D.C.: June 26, 2014).

[30]Duncan Hunter National Defense Authorization Act for Fiscal Year 2009, Pub. L. No. 110-417, § 814 (2008).

According to the statute, the configuration steering board should, among other things, prevent unnecessary changes to program requirements and system configuration that could have an adverse impact on the program's cost or schedule. While the scope of some programs was reduced, other programs were approved for increases in capability. Adding requirements to a program after system development start may lead to cost increases. Accordingly, the Fire Scout and Warfighter Information Network-Tactical Increment 2 program both report that the proposed increases to their capability or requirements would affect their cost.

5. **Eighteen of the 38 current programs we assessed have held a milestone B since 2009. Ten of these programs were granted a total of 19 different waivers to selected components of mandatory program certifications required at this point.**[31] **DOD most frequently waived components of the certifications related to ensuring full funding availability for product development and completion of a preliminary design review prior to milestone B.** The certifications required for programs at milestone B help programs reduce problems in system development and production. A waiver may be granted for any one or more components of certifications if it is determined by the milestone decision authority that without the waiver the department would be unable to meet critical national security objectives. Since 2009, 18 programs we assessed held a milestone B review and a total of 19 different waivers to selected components of certifications have been granted to 10 of these programs. Table 6 below lists some of the waivers granted to the 10 programs.

[31] 10 U.S.C. § 2366b.

Table 6: Selected Components of Mandatory Certification Waivers Granted since 2009

Program name	Funding available to execute program	Formal preliminary design review was conducted	Cost, schedule, and performance trade-offs considered
Armored Multi-Purpose Vehicle	✓	✓	
Air and Missile Defense Radar		✓	
Combat Rescue Helicopter	✓	✓	✓
F-22 Increment 3.2B	✓		✓
Next Generation Operational Control System	✓		✓
KC-46 Tanker Modernization Program	✓	✓	✓
Joint Light Tactical Vehicle	✓		
Littoral Combat Ship	✓		✓
Littoral Combat Ship - Mission Packages	✓	✓	
VH-92A Presidential Helicopter Replacement		✓	

Source: GAO analysis of questionnaire data. | GAO-15-342SP

We focused on three components of the certifications that establish practices important to achieving a match between program requirements and resources at the start of system development. The most frequent waiver granted by DOD was the requirement to certify that funding is available within the five-year defense spending plan to execute product development and production as planned; 8 programs representing an investment of nearly $119 billion report receiving a waiver for this requirement. According to department officials, the timing of these programs' milestone decisions coincided with decision points about the department's upcoming budget request and, as a result, the differences between the programs' cost estimates and the budget proposal could not be reconciled without the budget being revised or delays to the milestones. Officials stated that these waivers were granted with the rationale that the funding would be realigned in the next fiscal year. While 4 of these 8 programs have since aligned their budgets with that of the department, thereby removing the waiver, in one case the waiver was not removed for more than 3 years. DOD has yet to remove this waiver for the other 4 programs—the Armored Multi-Purpose Vehicle, Combat Rescue Helicopter, Littoral Combat Ship, and Littoral Combat Ship - Mission Packages.

Six programs received a waiver from the requirement to conduct a preliminary design review. These programs cited a variety of reasons for seeking this waiver including the lack of a technology development phase due to the use of existing technologies, the intent to conduct preliminary design review after milestone B, and the presumed negative effect on cost and schedule if the review was held prior to this milestone. An additional 5 programs received a waiver for the requirement to certify that appropriate trade-offs among cost, schedule, and performance objectives had been made to ensure long-term program affordability. While tailoring programs is encouraged by the department, not certifying that these steps have been taken before committing the significant funding necessary for programs' system development can introduce the risk of discovering problems later.

The future programs we assessed currently intend to apply for waivers as well. For example, four programs—Amphibious Combat Vehicle, Common Infrared Countermeasure, Fleet Replenishment Oiler, and Presidential Aircraft Recapitalization—plan to seek waivers from the requirement to conduct a preliminary design review prior to their milestone B decision.

These certifications help ensure that a program will deliver the capabilities required with the resources—cost, schedule, technology, and personnel—available. Not adhering to these certification requirements may lead to the same kinds of practices that perpetuate the significant cost growth and schedule delays that have persisted in the acquisition system for decades. We have previously concluded that decision-makers should ensure that new programs exhibit sound acquisition principles before programs are approved and funded and that the highest point of leverage to achieve this is at the start of a new program. Granting programs waivers to these requirements indicates that decision-makers are electing to fund programs without sufficient knowledge of their potential cost and their effect on the rest of the portfolio.

6. **Twenty-five of the 38 current programs we assessed reported software development as a high-risk area. Of these, 19 programs plan to begin production prior to completing the software development necessary for integration with system hardware and achieving baseline capabilities.** We found in 2004 that major defense acquisition programs were becoming increasingly reliant on

software to achieve their performance characteristics.[32] 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.

Sixty-six percent of the current programs we assessed reported that their software development was or is a high-risk area, but only four programs described themselves as a software intensive or hybrid program. The three most common reasons cited for designating software development as high-risk include:

- completing the software effort needed to conduct developmental testing successfully (21 programs);
- completing the originally planned software effort has proved to be more difficult than expected (19 programs); and
- hardware design changes have required additional software development efforts (15 programs).

The questionnaire sent to the 38 current programs we assessed listed a number of metrics for monitoring software development that we derived from our 2004 report and the review of other materials. Some of these metrics include the monitoring of progress against established goals, the size of the software effort and type of code used, and the number of defects that require design or engineering changes. Over half of the programs we assessed report employing 9 of the 10 software metrics listed. For example,

- Twenty-four programs report that they are using earned value management, or the analysis of cost and schedule variances, to assess progress. Nine of the 24 programs report that actual values are not currently meeting the expected cost and schedule values for this metric.
- Twenty-seven programs report tracking the size of their software effort and 19 programs report that software growth is in control.

[32]GAO, *Defense Acquisitions: Stronger Management Practices Are Needed to Improve DOD's Software-Intensive Weapon Acquisitions*, GAO-04-393 (Washington, D.C.: March 1, 2004).

- Twenty programs report tracking the number of software defects that require design or engineering changes and seven of these programs are not meeting their expected values for this metric. Large numbers of defects, particularly those that are found after the phase in which they were created, indicate that problems may exist and lead to increased cost and schedule due to rework and the need to review development processes so that defects are found earlier.

Nineteen of the 38 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. However, a recent report from DOD's Director of Operational Test and Evaluation found that many capability shortfalls in military systems are directly related to software failures and poor software maintenance capabilities.[33] While some concurrency may be necessary when rapidly fielding urgently needed warfighter capabilities, pursuing software development while the system is in production may introduce risks if problems are discovered late in testing; especially when such problems necessitate hardware changes to supplement the software or require the acceptance of software whose reliability falls short of overall system requirements.

7. **Eleven of the 15 current programs we assessed, that have started production, plan to perform 30 percent or more of their developmental testing during production despite the increased risk of design changes and costly retrofits. Five of these programs expect to place more than 20 percent of their procurement quantities under contract before developmental testing is completed with one planning to place its entire procurement quantity under contract.** Beginning production before demonstrating that a design is mature and that a system will work as intended increases the risk of discovering deficiencies during production that could require substantial design changes and costly modifications to systems already built. The intent of developmental testing is to demonstrate the maturity of a design and to discover and fix design and performance problems before a system enters production. However, 11 of the 15 current programs we assessed that

[33]DOD, Director, Operational Test and Evaluation, *FY 2013 Annual Report,* January 2014.

have started production intend to or have already executed 30 percent or more of their developmental testing concurrent with production. Six of the 11 programs reported completing their developmental testing and two of these programs—Littoral Combat Ship - Mission Packages and WIN-T Increment 2—reported having quality problems during production.

Two of the programs currently in developmental testing expect to have more than 10 percent of their total procurement quantities under contract before developmental testing is complete. For example, the M109A7 Family of Vehicles program plans to have 133 vehicles, or about 24 percent of its total procurement quantity under contract, at a cost of just over $1.4 billion, before completing developmental testing in 2016.

Another 12 current programs we assessed are scheduled to make a production decision in the coming years and five of them intend to execute 30 percent or more of their developmental testing concurrent with production. Four of these 12 programs expect to have more than 10 percent of their total procurement quantity under contract before developmental testing completes running the risk of costly retrofits to existing systems or changes to active production lines.

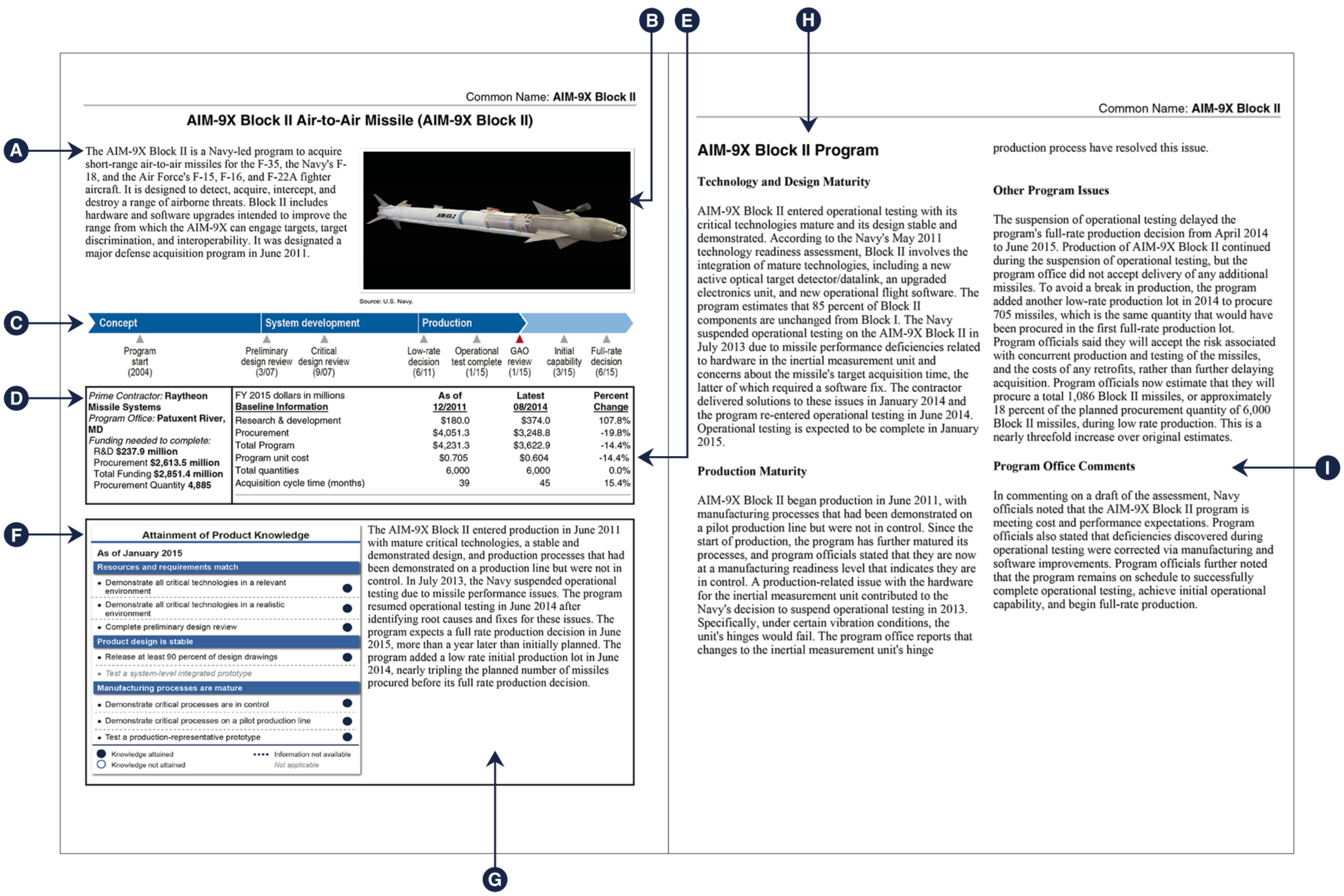
DOD policy allows some degree of concurrency between initial production and developmental testing. However, concurrency can increase the risk of design changes and cost of retrofits after production has started. This is one practice that has perpetuated the unsatisfactory results that have persisted in acquisitions through the decades. For example, in our prior work, we found that F-35 had an acquisition strategy that contained high levels of concurrency between development, testing, and production.[34] Consequently, the program experienced significant cost and schedule growth, as well as performance shortfalls. Taking a similar approach in current programs, as identified by our analysis above, could lead to similarly poor acquisition outcomes.

[34]GAO, *F-35 Joint Strike Fighter: Problems Completing Software Testing May Hinder Delivery of Expected Warfighting Capabilities,* GAO-14-322 (Washington, D.C.: March 24, 2014).

Assessments of Individual Programs

This section contains assessments of individual weapon programs. Each assessment presents data on the extent to which programs are following a knowledge-based acquisition approach to product development, and other program information. In total, we present information on 53 programs. For 37 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. Thirty-five of these 37 two-page assessments are of major defense acquisition programs, most of which are in development or early production and two assessments are of programs that were projected to become major defense acquisition programs during or soon after our review. See figure 12 for an illustration of the layout of each two-page assessment. In addition, we produced one-page assessments on the current status of 16 programs, which include 15 future major defense acquisition programs, and one major defense acquisition program that is well into production.

Figure 12: 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 2015

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

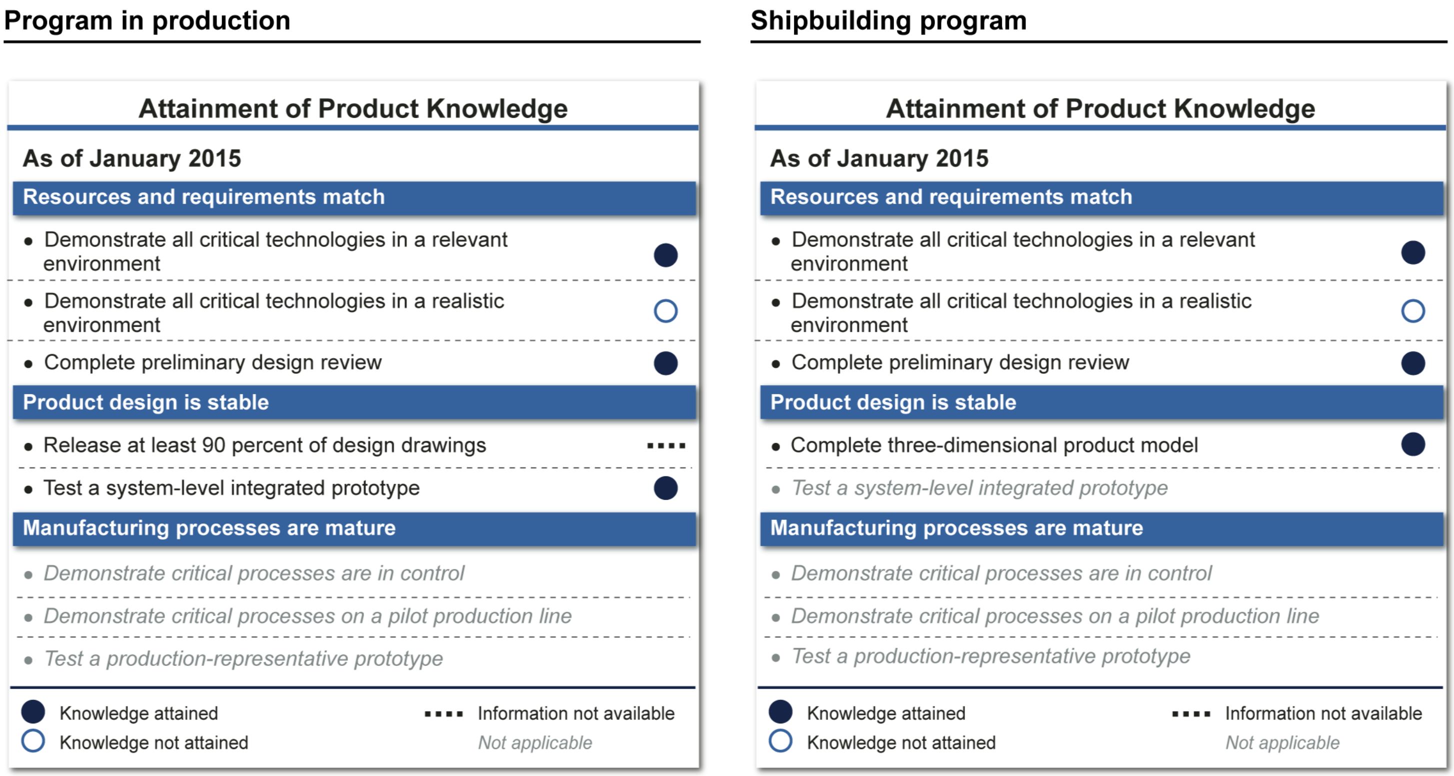
Source: GAO analysis. | GAO-342SP

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. As illustrated in figure 12 above, the scorecard displays eight 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 detailed 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 13 for examples of the knowledge scorecards we use to assess these different types of programs.

Figure 13: Examples of Knowledge Scorecards



Source: GAO. | GAO-15-342SP

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 accepted on the Electronic Subcontracting Reporting System (eSRS).[35] We reviewed this information for 32 of the major defense acquisition programs in our assessment that reported contract information in their December 2013 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 accepted by the government. The government uses individual subcontracting reports on eSRS as one method of monitoring

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

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 this data is not captured in the individual subcontracting reports. Information gathered for this analysis is presented in appendix VI.

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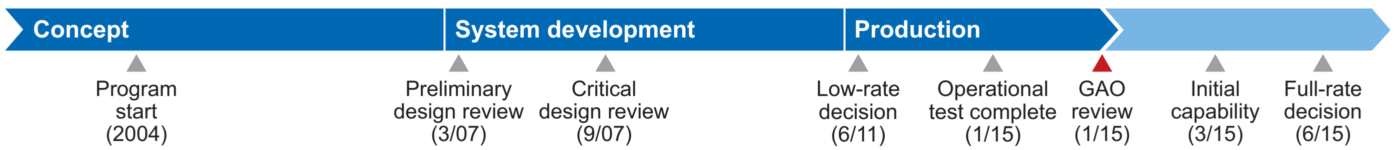
AIM-9X Block II Air-to-Air Missile (AIM-9X Block II)

The AIM-9X Block II is a Navy-led program to acquire short-range air-to-air missiles for the F-35, the Navy's F-18, and the Air Force's F-15, F-16, and F-22A fighter aircraft. It is designed to detect, acquire, intercept, and destroy a range of airborne threats. Block II includes hardware and software upgrades intended to improve the range from which the AIM-9X can engage targets, target discrimination, and interoperability. It was designated a major defense acquisition program in June 2011.

Source: U.S. Navy.



Program Essentials

Prime contractor: Raytheon Missile Systems
Program office: Patuxent River, MD
Funding needed to complete:
- R&D: $237.9 million
- Procurement: $2,613.5 million
- Total funding: $2,851.4 million
- Procurement quantity: 4,885

Program Performance (fiscal year 2015 dollars in millions)

	As of 12/2011	Latest 08/2014	Percent change
Research and development cost	$180.0	$374.0	107.8
Procurement cost	$4,051.3	$3,248.8	-19.8
Total program cost	$4,231.3	$3,622.9	-14.4
Program unit cost	$.705	$.604	-14.4
Total quantities	6,000	6,000	0.0
Acquisition cycle time (months)	39	45	15.4

The AIM-9X Block II entered production in June 2011 with mature critical technologies, a stable and demonstrated design, and production processes that had been demonstrated on a production line but were not in control. In July 2013, the Navy suspended operational testing due to missile performance issues. The program resumed operational testing in June 2014 after identifying root causes and fixes for these issues. The program expects a full-rate production decision in June 2015, more than a year later than initially planned. The program added a low-rate initial production lot in June 2014, nearly tripling the planned number of missiles procured before its full-rate production decision.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• Demonstrate critical processes are in control	●
• Demonstrate critical processes on a pilot production line	●
• Test a production-representative prototype	●

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

AIM-9X Block II Program

Technology and Design Maturity

AIM-9X Block II entered operational testing with its critical technologies mature and its design stable and demonstrated. According to the Navy's May 2011 technology readiness assessment, Block II involves the integration of mature technologies, including a new active optical target detector/datalink, an upgraded electronics unit, and new operational flight software. The program estimates that 85 percent of Block II components are unchanged from Block I. The Navy suspended operational testing on the AIM-9X Block II in July 2013 due to missile performance deficiencies related to hardware in the inertial measurement unit and concerns about the missile's target acquisition time, the latter of which required a software fix. The contractor delivered solutions to these issues in January 2014 and the program re-entered operational testing in June 2014. Operational testing is expected to be complete in January 2015.

Production Maturity

AIM-9X Block II began production in June 2011, with manufacturing processes that had been demonstrated on a pilot production line but were not in control. Since the start of production, the program has further matured its processes, and program officials stated that they are now at a manufacturing readiness level that indicates they are in control. A production-related issue with the hardware for the inertial measurement unit contributed to the Navy’s decision to suspend operational testing in 2013. Specifically, under certain vibration conditions, the unit’s hinges would fail. The program office reports that changes to the inertial measurement unit’s hinge production process have resolved this issue.

Other Program Issues

The suspension of operational testing delayed the program's full-rate production decision from April 2014 to June 2015. Production of AIM-9X Block II continued during the suspension of operational testing, but the program office did not accept delivery of any additional missiles. To avoid a break in production, the program added another low-rate production lot in 2014 to procure 705 missiles, which is the same quantity that would have been procured in the first full-rate production lot. Program officials said they will accept the risk associated with concurrent production and testing of the missiles, and the costs of any retrofits, rather than further delaying acquisition. Program officials now estimate that they will procure a total 1,086 Block II missiles, or approximately 18 percent of the planned procurement quantity of 6,000 Block II missiles, during low rate production. This is a nearly threefold increase over original estimates.

Program Office Comments

In commenting on a draft of the assessment, Navy officials noted that the AIM-9X Block II program is meeting cost and performance expectations. Program officials also stated that deficiencies discovered during operational testing were corrected via manufacturing and software improvements. Program officials further noted that the program remains on schedule to successfully complete operational testing, achieve initial operational capability, and begin full-rate production.

Air and Missile Defense Radar (AMDR)

The Navy's Air and Missile Defense Radar (AMDR) is a next-generation radar system designed to provide ballistic missile defense, air defense, and surface warfare capabilities. AMDR will consist of an S-band radar for ballistic missile and air defense, an X-band radar for horizon search, and a radar suite controller that controls and integrates the two radars. AMDR will initially support DDG 51 Flight III. The Navy expects AMDR to provide a scalable radar architecture that can be used to defeat advanced threats.

Source: U.S. Navy.

Concept		System development				Production		
Program start (9/10)	Development start (10/13)	Preliminary design review (8/14)	GAO review (1/15)	Critical design review (4/15)	Low-rate decision (9/17)	Start operational test (6/23)	Initial capability (9/23)	

Program Essentials

Prime contractor: Raytheon
Program office: Washington, DC
Funding needed to complete:
- R&D: $657.7 million
- Procurement: $3,396.8 million
- Total funding: $4,054.5 million
- Procurement quantity: 22

Program Performance (fiscal year 2015 dollars in millions)

	As of 10/2013	Latest 08/2014	Percent change
Research and development cost	$1,919.9	$1,766.3	-8.0
Procurement cost	$3,970.8	$3,396.8	-14.5
Total program cost	$5,920.4	$5,192.6	-12.3
Program unit cost	$269.110	$236.028	-12.3
Total quantities	22	22	0.0
Acquisition cycle time (months)	158	156	-1.3

AMDR's four critical technologies are approaching full maturity, and officials believe they will meet DDG 51 Flight III's schedule requirements. The program completed its final preliminary design review in August 2014, and anticipates a critical design review in April 2015. The contractor is producing an engineering development model consisting of a full-sized, single faced array and the required software. This array will go through testing at the contractor's indoor facilities and then be installed and tested at the Navy's land-based test facility after critical design review—but program officials stated it will not be tested at-sea prior to installation on DDG 51. DOD's Director, Operational Test and Evaluation (DOT&E), has not approved the Test and Evaluation Master Plan due to scope concerns with the Navy's planned testing activities.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

AMDR Program

Technology and Design Maturity

All four of AMDR's critical technologies—digital-beam-forming; transmit-receive modules; software; and digital receivers/exciters—are approaching full maturity, and program officials state that AMDR is on pace to meet DDG 51 Flight III's schedule requirements. In 2015, the contractor is expected to complete an engineering development model consisting of a single full-sized 14 foot radar array—as opposed to the final four array configuration planned for installation on DDG 51 Flight III—and begin testing in the contractor's indoor facilities. Following the critical design review, scheduled for April 2015, the program plans to install the array in the Navy's land-based radar test facility in Hawaii for further testing in a more representative environment. However, the Navy has no plans to test AMDR in a realistic (at-sea) environment prior to installation on the lead DDG 51 Flight III ship. Though the Navy is taking some risk reduction measures, there are only 15 months planned to install and test the AMDR prototype prior to making a production decision. Delays may cause compounding effects on testing of upgrades to the Aegis combat system since the Navy plans to use the AMDR engineering development model in combat system integration and testing.

In August 2014, AMDR completed its final preliminary design review, which assessed both hardware and software. The total number of design drawings required for AMDR has not yet been determined and will be finalized at the program's critical design review. However, AMDR officials are confident that the robust technology in the prototype represents the physical dimensions, weight, and power requirements to support DDG 51 Flight III integration. The AMDR program office provided an initial interface control document listing AMDR specifications to the DDG 51 Flight III program office. Ensuring correct AMDR design parameters is important since the available space, weight, power, and cooling for DDG 51 Flight III is constrained, and design efforts for the ship will begin before AMDR is fully matured.

The AMDR radar suite controller requires significant software development, with 1.2 million lines of code and four planned builds. The program also plans to apply an open systems approach to available commercial hardware to decrease development risk and cost. The program office identified that the first of four planned builds is complete, has passed the Navy's formal qualification testing and will enter developmental testing next summer. Each subsequent build will add more functionality and complexity. AMDR will eventually need to interface with the Aegis combat management system found on DDG 51 destroyers. This interface will be developed in later software builds for fielding in 2020, and the Navy plans on conducting early combat system integration and risk reduction testing prior to making a production decision.

Other Program Issues

AMDR still lacks a Test and Evaluation Master Plan approved by DOD's Director, Operational Test and Evaluation (DOT&E), as required by DOD policy. DOT&E expressed concerns with the lack of a robust live-fire test plan involving AMDR and the Navy's self-defense test ship. According to program officials, their current test plan's models will provide sufficient data to support validation and accreditation and thus verify system performance.

Program Office Comments

According to the Navy, AMDR is on track to deliver a capability 30 times greater than the radar it will replace. To mitigate development risk and deliver AMDR's software at the earliest possible delivery date, the contractor is implementing software development approaches to improve productivity, in coordination with robust testing, modeling, and live flight test simulations. Further, an AMDR hardware facility—including a fully functioning portion of AMDR's processing equipment and a software integration lab—is operating at the contractor's facility to support iterative testing ahead of, and then in support of, production of the engineering development model. In December 2014, a hardware specific critical design review was successfully completed demonstrating that technical performance measures are in compliance with requirements and the hardware design is sufficiently mature to complete detailed design, and will proceed to engineering development model array production.

Airborne and Maritime/Fixed Station Joint Tactical Radio System (AMF JTRS)

The Army's AMF JTRS program plans to acquire two non-developmental software-defined radios, the Small Airborne Link 16 Terminal (SALT) and the Small Airborne Networking Radio (SANR), and associated equipment for integration into Army rotary wing and unmanned aerial systems. In 2014, the Army split SALT and SANR into separate sub-programs. The Army is currently reassessing its approach to the SANR program.

Source: U.S. Army.

Concept | System development | Production

- Development start (3/08)
- GAO review (1/15)
- Low-rate decision (SALT) (7/16)
- Initial capability (SALT) (10/18)
- Low-rate decision (SANR) (4/23)
- Initial capability (SANR) (10/26)

Program Essentials

Prime contractor: TBD
Program office: Aberdeen, MD
Funding needed to complete:
R&D: $102.1 million
Procurement: $1,803.1 million
Total funding: $1,905.2 million
Procurement quantity: 15,460

Program Performance (fiscal year 2015 dollars in millions)

	As of 10/2008	Latest 08/2014	Percent change
Research and development cost	$2,060.0	$1,573.9	-23.6
Procurement cost	$6,576.0	$1,884.1	-71.3
Total program cost	$8,636.0	$3,458.0	-60.0
Program unit cost	$.319	$.221	-30.7
Total quantities	27,102	15,652	-42.2
Acquisition cycle time (months)	80	223	178.8

In July 2012, as part of an overall JTRS reorganization, the Under Secretary of Defense for Acquisition, Technology, and Logistics directed a restructured acquisition approach to acquire a modified non-developmental item which leverages the prior investment in the AMF program to the maximum extent practical. The procured radios will be post-production items and will be tested for technical maturity as part of the formal testing process. AMF JTRS will not be part of the development process.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	....
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

AMF JTRS Program

Technology, Design, and Production Maturity

While program officials have identified critical technologies, the program intends to procure existing radios which will be tested to demonstrate technology maturity as part of the overall test and demonstration process. The program does not intend to develop any new technologies for the program. In July 2012, as part of an overall JTRS reorganization, the Under Secretary of Defense for Acquisition, Technology, and Logistics directed a restructured acquisition approach to acquire a modified non-developmental item which leverages the prior investment in the AMF program to the maximum extent practical. This restructuring shifted the program from a development effort supporting Army, Air Force, and Navy platforms to one that supports Army aviation efforts. In 2014, the Army split the Small Airborne Link 16 Terminal Radio (SALT) and Small Airborne Networking Radio (SANR) into separate sub-programs. Both the SALT and SANR subprograms are in the pre-solicitation phase and no contracts have been awarded. Program officials are currently awaiting approval of the revised acquisition strategy before they proceed with the release of the request for proposals. AMF JTRS will not be part of the development process.

Program officials stated that, due to the non-developmental approach, they do not currently have an estimate of the maturity of the design. The Army will not develop any software for the program. The vendor will be required to complete the software development effort prior to delivery.

Program officials noted that there are no plans to conduct any additional systems engineering design reviews beyond what was completed for the earlier developmental program. However, program officials plan to conduct risk reduction testing for the non-developmental items in the SALT sub-program in preparation for operational testing, currently scheduled for fiscal year 2017 after the low-rate initial production contract has been awarded.

Other Program Issues

The Army approved a new acquisition program baseline for AMF JTRS in May 2014. Under this new baseline, the program's acquisition cost decreased slightly. Program officials told us that this decrease resulted from delays to the SANR sub-program, which has been deferred past fiscal year 2019. Program officials also stated that they plan to complete an affordability analysis for each sub-program.

Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments which were incorporated where deemed appropriate.

Armored Multi-Purpose Vehicle (AMPV)

The Army's Armored Multi-Purpose Vehicle (AMPV) is the replacement to the M113 family of vehicles. The AMPV will replace the M113 in five mission roles: general purpose, medical evacuation, medical treatment, mortar carrier, and mission command. The Army has determined that development of the AMPV is necessary due to mobility, survivability and force protection deficiencies identified with the M113, as well as space, weight, power and cooling limitations that prevent the incorporation of the inbound Army network and future technologies.

Source: U.S. Army.

Concept | System development | Production

- Development start (12/14)
- GAO review (1/15)
- Design review (6/16)
- Low-rate decision (3/19)
- End operational test (6/21)
- Initial capability (6/22)

Program Essentials

Prime contractor: BAE Systems
Program office: Warren, MI
Funding needed to complete:
R&D: $920.0 million
Procurement: $9,736.0 million
Total funding: $10,656.0 million
Procurement quantity: 2,897

Program Performance (fiscal year 2015 dollars in millions)

	As of	Latest 12/2014	Percent change
Research and development cost	NA	$987.0	NA
Procurement cost	NA	$9,736.0	NA
Total program cost	NA	$10,723.0	NA
Program unit cost	NA	$3.701	NA
Total quantities	NA	2,897	NA
Acquisition cycle time (months)	NA	90	NA

The AMPV program entered system development in December 2014 with its critical technologies fully mature based on the results of a technology readiness assessment conducted in October 2014. The program received a waiver for conducting competitive prototyping, and obtained a waiver to hold a preliminary design review after the start of system development. While the AMPV program does not intend to develop new technologies and plans to use readily available components from legacy systems, choosing to forego prototyping and deferring systems engineering reviews could limit the knowledge gained prior to development start.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
Demonstrate all critical technologies in a relevant environment	●
Demonstrate all critical technologies in a realistic environment	●
Complete preliminary design review	○
Product design is stable	
Release at least 90 percent of design drawings	
Test a system-level integrated prototype	
Manufacturing processes are mature	
Demonstrate critical processes are in control	
Demonstrate critical processes on a pilot production line	
Test a production-representative prototype	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

AMPV Program

Technology Maturity

The AMPV program entered system development in December 2014 with its critical technologies fully mature. An independent review team conducted an assessment of the program's ten critical technology areas—including automotive systems, power train cooling, troop protection, and others—and determined that candidate technologies for these areas exist and are fully mature. According to program officials, based on industry responses to requests for information and proposal data reviewed by an independent team, no further technology development or design innovations are needed to meet AMPV requirements, and integration risks are low to moderate.

Other Program Issues

The AMPV program was granted waivers from the requirements to conduct competitive prototyping and a preliminary design review prior to system development. The AMPV acquisition strategy calls for derivatives of existing military vehicles that leverage existing mission equipment packages or non-developmental items for each of the mission roles. The Army has taken other actions to reduce risk as well, including reducing requirements to ensure no technology development is needed. According to program officials, market research identified examples of mature vehicles and subsystems and the program received multiple offers with demonstrated technology and engineering solutions. Therefore, the program believed there were negligible benefits to be achieved by conducting competitive prototyping and a preliminary design review before entering system development. While this acquisition strategy will reduce development risk, choosing to forego prototyping and defer systems engineering reviews could limit the amount of knowledge gained on the program and leaves it vulnerable to cost and schedule increases if issues are identified after the start of system development. The AMPV program's preliminary design review is planned to occur by June 2015 and the critical design review is expected to occur by June 2016.

AMPV's acquisition strategy also calls for selection of a single contractor for system development, and provides for three low-rate initial production options within the system development contract. The program awarded a cost-plus-incentive-fee contract for system development with a fixed-price incentive option for low-rate initial production to BAE Systems in December 2014. The AMPV contract will include engineering and manufacturing development and low-rate initial production incentives for cost and reliability.

Program Office Comments

In commenting on a draft of this assessment, the Army provided technical comments, which were incorporated as appropriate.

CH-53K Heavy Lift Replacement Helicopter (CH-53K)

The Marine Corps' CH-53K heavy-lift helicopter is intended to transport armored vehicles, equipment, and personnel to support operations deep inland from a sea-based center of operations. The CH-53K is expected to replace the legacy CH-53E helicopter and provide increased range and payload, survivability and force protection, reliability and maintainability, and coordination with other assets, while reducing total ownership cost.

Source: Sikorsky Aircraft Corporation.

Concept | **System development** | **Production**

Program start	Development start	Design review	GAO review	Production readiness review	Low-rate decision	Operational test complete	Initial capability
(11/03)	(12/05)	(7/10)	(1/15)	(3/16)	(6/16)	(9/18)	(7/19)

Program Essentials

Prime contractor: Sikorsky Aircraft Corporation
Program office: Patuxent River, MD
Funding needed to complete:
R&D: $2,171.6 million
Procurement: $18,559.2 million
Total funding: $20,759.1 million
Procurement quantity: 194

Program Performance (fiscal year 2015 dollars in millions)

	As of 12/2005	Latest 12/2013	Percent change
Research and development cost	$4,637.7	$6,735.2	45.2
Procurement cost	$12,898.2	$18,559.2	43.9
Total program cost	$17,535.9	$25,335.5	44.5
Program unit cost	$112.409	$126.677	12.7
Total quantities	156	200	28.2
Acquisition cycle time (months)	119	163	37.0

The CH-53K program continues to move forward toward production, but has not yet fully matured its critical technologies or demonstrated that its design can perform as expected. Failures found during qualification testing have led to a number of unexpected redesigns, which have delayed testing and production. While the ground test vehicle has been delivered, and is currently undergoing tests, problems with qualification of parts have delayed delivery of the first few test aircraft as well as initial testing and first flight, thereby adding risk to the program's ability to execute its schedule.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	....
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

CH-53K Program

Technology and Design Maturity

The CH-53K program's two critical technologies—which are housed within the main rotor blade and main gearbox—have yet to achieve full maturity nearly 10 years after the program began system development. These technologies have successfully been tested using the program's ground test vehicle and will continue to be evaluated when the program begins operational flight testing, which is expected to occur in 2015.

Unanticipated design changes to non-critical technology components have caused delays. For example, the CH-53K relies on a number of gear boxes which do not house critical technologies. Several of those gear boxes have suffered setbacks during qualification testing, which has resulted in unanticipated redesigns and schedule delays. In addition, the rear module assembly, which is part of the main gear box, but not associated with the critical technology it houses, required a modest redesign. Testing has also revealed problems with vibration in the drive shaft as well as temperature issues with the top deck engine exhaust. According to the program office, resolutions to these issues have been determined and the necessary redesigns have been made.

Program officials reported that the unanticipated number of redesigns has lead to schedule delays and changes to test plans. For example, the program's first test flight, which was already delayed by one year, will be further delayed while the program determines solutions to issues found in qualification testing. Some of these solutions will be temporary, allowing the program to move forward with testing while they simultaneously incorporate a long term solution. In one example, qualification testing of the main gear box rear assembly found that three gears—module output, input idler, and tail take-off—were not working as planned and would require redesigns. In the meantime, a temporary solution has been reached that will allow further testing, but will not allow full envelope testing.

Production Maturity

The program's ground test vehicle was delivered in October 2012 and is currently undergoing full aircraft systems testing. Initial testing of this aircraft, commonly referred to as "light off," began 11 months later than planned. According to program officials, production of the first engineering demonstration model test aircraft is complete, but the failures in qualification testing have prevented the program from moving forward with the first test flight. The program is taking steps to address these issues but qualification test failures add risk to the program's ability to execute its schedule. Production of the three remaining engineering test aircraft is ongoing, but has been hampered by the same issues that have delayed the first test flight.

Qualification failures resulted in instances where fully qualified parts are not available for incorporation onto test aircraft. In these instances, the program has substituted parts that, while qualified as safe for flight, have not yet been fully qualified. These parts will be substituted in the assembly process to enable test aircraft production to continue. As successfully tested, qualified parts become available, they will have to be retrofitted on the test aircraft, which could add further risk to the production and flight test schedule.

Program Office Comments

The program office concurred with this assessment and noted that it continues to address component, subsystem, and system issues as they arise in testing. Also, they noted that performance of the program continues to indicate that the system will meet technical and mission requirements.

Combat Rescue Helicopter (CRH)

The Air Force's Combat Rescue Helicopter (CRH) will recover personnel from hostile or denied territory as well as conduct humanitarian, civil search and rescue, disaster relief, and non-combatant evacuation missions. The CRH program is an effort to replace aging HH-60G Pave Hawk helicopters. The first effort to replace the HH-60G, the Combat Search and Rescue Replacement Vehicle (CSAR-X), was canceled in 2009 because of cost concerns stemming from technology development.

Source: 2013 Sikorsky Aircraft Corp. Used with permission for support of CRH.

Concept | **System development** | **Production**

- Development start (6/14)
- GAO review (1/15)
- Design review (7/17)
- Low-rate decision (10/19)
- Start operational test (10/20)
- Initial capability (4/21)
- Full-rate decision (10/21)

Program Essentials

Prime contractor: Sikorsky Aircraft Corporation
Program office: Wright-Patterson AFB, OH
Funding needed to complete:
R&D: $1,845.8 million
Procurement: $6,212.1 million
Total funding: $8,082.1 million
Procurement quantity: 103

Program Performance (fiscal year 2015 dollars in millions)

	As of	Latest 06/2014	Percent change
Research and development cost	NA	$1,992.3	NA
Procurement cost	NA	$6,212.1	NA
Total program cost	NA	$8,228.5	NA
Program unit cost	NA	$73.469	NA
Total quantities	NA	112	NA
Acquisition cycle time (months)	NA	82	NA

The Air Force's CRH program began system development in June 2014 without identifying any critical technologies. The program was granted waivers for its technology to be demonstrated in a relevant environment as well as for competitive prototyping. Further, the program did not conduct any systems engineering technical reviews. The program's acquisition strategy states the CRH will modify an existing, flight proven helicopter by integrating mature subsystems and associated software. While the program has identified several planned enhancements to be incorporated from multiple H-60 variants onto the Sikorsky UH-60M helicopter—the platform being leveraged for the CRH—the program may not have gained sufficient knowledge to have entered development with the least amount of risk.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	▪▪▪▪
• Demonstrate all critical technologies in a realistic environment	▪▪▪▪
• Complete preliminary design review	○
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

CRH Program

Technology Maturity

The CRH program began system development in June 2014 without identifying any critical technologies. In transitioning from the cancelled CSAR-X program, the Air Force removed or lowered requirements for the notional aircraft to ensure technology development was not required. The CRH acquisition strategy currently states the program will modify an existing, flight proven helicopter by integrating mature subsystems and associated software. The CRH program has identified several planned enhancements to be incorporated from multiple H-60 variants onto the UH-60M helicopter—the platform being leveraged for the CRH. The planned enhancements include a higher capacity electrical system, larger capacity main fuel tanks for extended range, an armor suite for crew protection, situational awareness enhancements which include various tactical data links, and an existing UH-60M engine. The program is also considering integrating a landing sensor, which is being developed to aid pilots with landing in degraded visual environments. A program official stated that, if they are not mature, these technologies will not be integrated on the CRH.

DOD authorized the program to bypass technology development and enter the acquisition process at system development. In approving the program's entry into system development, the Under Secretary of Defense for Acquisition, Technology, and Logistics waived requirements for five components of a certification completed before system development begins: 1) consideration of appropriate trade-offs among cost, schedule, and performance objectives to ensure the program is affordable; 2) the availability of funding through the next five years; 3) a preliminary design review; 4) demonstration of technology in a relevant environment; and 5) competitive prototyping. This decision was also supported by the Assistant Secretary of Defense for Research and Engineering. According to program documentation, the first two waivers were granted due to funding constraints at the time of the decision, and the Air Force plans to realign funding to fully support the program in the fiscal year 2016 budget process. The program plans to satisfy the requirement for a preliminary design review in April 2016, approximately 22 months after contract award. For the fourth waiver, the undersecretary determined that a technology readiness assessment was not required based upon the maturity of the required technology presented at the review. As a follow-up to this waiver, the program plans to conduct a technology readiness assessment in the summer of 2015. The need for competitive prototyping was waived in 2012 due to the determination that the cost of producing the competitive prototyping would exceed the expected life-cycle benefits.

Although the program office designed their acquisition strategy to ensure only mature technologies will be incorporated into the CRH, by waiving both competitive prototyping and the demonstration of technology in a relevant environment, and forgoing early systems engineering technical reviews, the program may not have gained sufficient knowledge to enter development with the least amount of risk. In our previous work, we have found acquisition programs which complete a preliminary design review and demonstrate that all technologies are mature prior to starting development typically have better cost and schedule outcomes.

Program Office Comments

In commenting on a draft of this assessment, the program office noted that, while the CRH is leveraging the UH-60M helicopter as its platform, it is also integrating mature technologies from multiple H-60 variants—including avionics, mission planning, and refueling capabilities. The CRH acquisition strategy is based on procuring technologies that are sufficiently mature, thus the program was approved for entry into system development. The program office also stated that it has implemented a risk management process across the CRH program. Based on a joint risk management board held in December 2014, the government and contractor did not identify any major risks—including risks related to technical maturity. In addition, the program office stated that mitigation plans have been prepared for all risks. The program office also provided technical comments, which were incorporated as appropriate.

DDG 1000 Zumwalt Class Destroyer (DDG 1000)

The Navy's DDG 1000 destroyer is a multimission surface ship designed to provide advanced capability for littoral operations and land-attack in support of forces ashore. The ship will feature an electric-drive propulsion system, a total ship computing environment, and an advanced gun system. The lead ship was launched in October 2013, but delivery (comprised of the ship's hull, mechanical, and electrical systems) has slipped from October 2014 until at least August 2015. Construction is underway on the remaining two ships in the class.

Source: Bath Iron Works.

Concept | System development | Production

- Program start (1/98)
- Development start (3/04)
- Production decision (11/05)
- Lead-ship fabrication start (2/09)
- GAO review (1/15)
- Lead-ship delivery (8/15)
- Operational evaluation (9/17)
- Initial capability (9/18)

Program Essentials

Prime contractor: BAE Systems, Bath Iron Works, Huntington Ingalls Industries, Raytheon
Program office: Washington, DC
Funding needed to complete:
R&D: $328.1 million
Procurement: $960.4 million
Total funding: $1,288.6 million
Procurement quantity: 0

Program Performance (fiscal year 2015 dollars in millions)

	As of 1/1998	Latest 12/2013	Percent change
Research and development cost	$2,412.7	$10,608.0	339.7
Procurement cost	$34,445.7	$11,888.8	-65.5
Total program cost	$36,858.3	$22,496.9	-39.0
Program unit cost	$1,151.823	$7,498.954	551.1
Total quantities	32	3	-90.6
Acquisition cycle time (months)	128	248	93.8

While the DDG 1000's design is largely mature and the program has made progress in developing its critical technologies and delivering mission system equipment, the program faces significant risks as ongoing development and shipboard testing of technologies may result in design changes. The delivery of the lead ship's hull, mechanical, and electrical systems is now expected in August 2015, causing a schedule breach to the program's baseline. The Navy faces significant challenges in meeting that date. Shipboard testing of the hull, mechanical, and electrical systems is lagging behind schedule, which will likely affect the timing of installation and activation of any remaining mission system equipment, as well as verification that the integrated combat systems, ship systems, and support systems can meet performance requirements.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
Demonstrate all critical technologies in a relevant environment	●
Demonstrate all critical technologies in a realistic environment	○
Complete preliminary design review	●
Product design is stable	
Complete three-dimensional product model	●
Test a system-level integrated prototype	
Manufacturing processes are mature	
Demonstrate critical processes are in control	
Demonstrate critical processes on a pilot production line	
Test a production-representative prototype	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

DDG 1000 Program

Technology Maturity

The DDG 1000 program has made progress in developing its critical technologies, but only 3 of 11 are fully mature and the remaining eight will not be demonstrated in a realistic environment until activation on the lead ship. As of September 2014, almost all of the equipment for the mission systems had been delivered and installed for the first and second ships, and the shipbuilder had begun energizing the ship's gas turbine generators—a key element of the integrated power system. Once energized, the program can begin to activate and test the propulsion and electrical systems without reliance on power from the shore. The program reported that the multifunction radar is installed on the lead ship, but testing of modifications to the radar to include the volume search capability is still ongoing. The program estimates that the shipboard radar will not begin activation until late 2015. According to program officials, seven software releases for the total ship computing environment have been completed to support lead ship activation and delivery, comprising 98 percent of the program's software development efforts. The program reported that land based testing of the advanced gun system and tactical guided flight tests of the long range land attack projectile have been completed.

Design and Production Maturity

The DDG 1000 design is largely mature, but ongoing development and shipboard testing of technologies may result in design changes. As of September 2014, the program reported that construction of the first two ships was 92 and 79 percent complete, respectively. However, slower than anticipated progress with the shipboard test program and compartment completions delayed delivery of the lead ship's hull, mechanical, and electrical systems beyond the program's baseline schedule of October 2014. While the Navy has not yet approved a revised baseline or determined the cost and schedule impacts of the delay, delivery is now expected in August 2015.

Other Program Issues

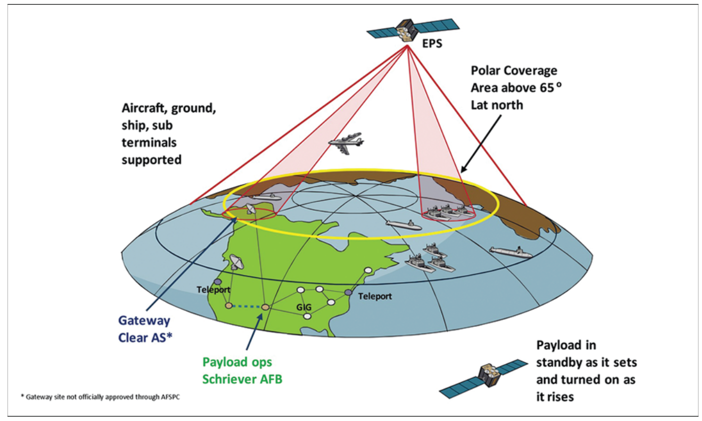
Shipboard testing of the hull, mechanical, and electrical systems is lagging behind schedule and will likely affect the timing of activation of any remaining mission system equipment, as well as verification that the ship can meet performance requirements. Consequently, there will be little time to identify and fix any problems prior to achieving initial operational capability. In a January 2014 assessment, DOD's Director, Operational Test and Evaluation noted risks with the program's development and test strategy and recommended that the Navy develop a strategy to mitigate the risk of not delivering substantial mission capability until after final contract trials. According to program officials, they are now reviewing the strategy of delivering lead ship hull, mechanical, and electrical systems followed by subsequent installation, activation, and testing of the ship's mission systems to an approach that resembles a more traditional approach that delivers the ship with the mission systems tested and activated to the maximum degree possible with the projected delivery date.

Program Office Comments

In commenting on a draft of this assessment, the Navy generally agreed with our findings and provided additional information. The Navy stated that the DDG 1000 program has made significant progress in the test and activation phase to support the earliest possible dockside and machinery trials leading to delivery of the ship's hull, mechanical, and electrical systems. For example, the Navy noted that the program successfully energized the lead ship's electrical system, brought the Engineering Control System and Total Ship Computing Environment online, activated three of four generators and both propulsion motors, and began rotating port shafting. In addition, the Navy added that initial radar testing has been completed and combat system integration has been initiated, making extensive use of engineering development models to provide early risk reduction and ensure a successful transition to shipboard operational use. The Navy also provided technical comments, which were incorporated where appropriate.

Enhanced Polar System (EPS)

The Air Force's Enhanced Polar System (EPS) is to provide next-generation protected extremely high frequency (EHF) satellite communications in the polar region. It will replace the current Interim Polar System and serve as a polar adjunct to the Advanced EHF (AEHF) system. EPS is to consist of three segments: two EHF payloads hosted on classified satellites, a gateway to connect modified Navy Multiband Terminals to other communication systems, and a control and planning segment (CAPS).



Source: LinQuest Corporation.

Concept | **System development/Production**

- Program initiation (12/07)
- Development start (4/14)
- Design review (7/14)
- GAO review (1/15)
- Payload-1 on orbit (6/15)
- Payload-2 on orbit (9/17)
- End operational test (2/18)
- Operational capability (6/18)

Program Essentials

Prime contractor: Northrop Grumman Information Systems (CAPS)
Program office: Los Angeles AFB, CA
Funding needed to complete:
R&D: $246.1 million
Procurement: $0.0 million
Total funding: $246.1 million
Procurement quantity: 0

Program Performance (fiscal year 2015 dollars in millions)

	As of	Latest 08/2014	Percent change
Research and development cost	NA	$1,412.7	NA
Procurement cost	NA	$0.0	NA
Total program cost	NA	$1,412.7	NA
Program unit cost	NA	$706.346	NA
Total quantities	NA	2	NA
Acquisition cycle time (months)	NA	126	NA

The EPS program formally entered system development in April 2014. The three segments of the EPS are in various stages of development. Although the EPS program's two EHF payloads are built, funding constraints resulted in reductions to the requirements for the control and planning and gateway segments, which required design changes and a revised acquisition strategy that delayed initial operational capability by two years. However, the reduction of capabilities also reduced the amount of development necessary and, according to the program office, reduced risk and cost. The program held its critical design review in July 2014 but does not have full visibility into design metrics for the EHF payloads. The program uses software related metrics to track progress on control and planning segment development.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• *Demonstrate all critical technologies in a realistic environment*	
• Complete preliminary design review	●
Product design is stable	
• *Release at least 90 percent of design drawings*	
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

EPS Program

Technology and Design Maturity

The EPS program formally entered system development in April 2014. The Under Secretary of Defense for Acquisition, Technology and Logistics directed the program to proceed to system development to synchronize the program's payload development schedule with the host satellite's production timeline. The program office for the host satellite awarded the payload development contract in July 2008, following an acquisition board equivalent to a system development decision. According to program officials, all hardware development and critical technologies are associated with the payloads. Because the payload development was conducted under a classified contract by another agency, EPS program officials did not have visibility into metrics—such as design drawings—used to track design maturity. Both payloads are built, and the first payload is fully integrated into the host satellite, which is currently undergoing final integrated system testing. The payloads are expected to be on orbit in fiscal years 2015 and 2017 respectively. All three segments of the program will be completed under a development effort. As such, there are no production related decisions for this program. While the three segments of the EPS program are at separate stages of development, the program completed extensive risk reduction activities with early system prototypes including flight equivalent payloads, a gateway engineering development model, and prototype control and planning software.

The control and planning segment (CAPS) is the critical path for the program. In contrast to payload development, the development of CAPS and the gateway segment were delayed as the program office used a design-to-cost approach to reduce CAPS and gateway development to the minimum capability needed due to funding constraints. The revised EPS acquisition strategy incorporating changes to CAPS and the gateway segment was approved in January 2012. The CAPS design contract was awarded in December 2012, and the program was approved to enter system development in April 2014. In July 2014, the program completed a successful system-level critical design review. According to program officials, CAPS is primarily a software development effort and utilizes commercial off-the-shelf hardware. As such, the program uses software related metrics, including software lines of code delivered, to track development progress. CAPS site installation is currently expected during the second and third quarters of fiscal year 2016. According to the program office, CAPS is not required for payload on-orbit testing, but it is required for inter-segment testing, which is scheduled for the first quarter of fiscal year 2017, and for overall functioning of the EPS system. According to the program office, the CAPS segment is progressing on schedule, and has adequate schedule margin.

The reduction of requirements nearly eliminated the development work for the gateway, which now requires only integration of existing equipment, and is considered low risk by the program office. Integration includes commercial off-the-shelf hardware such as routing and switching equipment, and terminals developed under other programs. The Navy's Space and Naval Warfare Systems Command Systems Center Pacific is responsible for integrating, testing, and installing the gateway segment.

Other Program Issues

According to the program office, the reduction in requirements and revised acquisition strategy reduced program risk by reducing or eliminating the amount of development and reducing overall program cost by about $1 billion. For example, under the original acquisition strategy, CAPS was planned as a sole-source follow-on increment to the AEHF mission control segment. The reduced requirements allowed for a competitive award for CAPS which, according the program office, provided significant cost savings. However, the changes also required altering the CAPS and Gateway design and a revised acquisition strategy which delayed operational capability from fiscal year 2016 to 2018.

Program Office Comments

In commenting on a draft of this assessment, EPS Program officials further noted the EPS program is on track to meet milestones. CAPS software development is about 40 percent complete as of December 2014, the gateway is on schedule for installation in the summer of 2015, and the payload is on track to meet on-orbit availability. The program office also provided technical comments, which were incorporated where deemed necessary.

Evolved Expendable Launch Vehicle (EELV)

The Air Force's EELV program provides critical spacelift support for DOD, national security, and other government missions. While the United Launch Alliance (ULA) is currently the sole provider of launch vehicles and support functions, the Air Force is working to certify new providers to compete for launch services. ULA provides launch services for EELV using two families of launch vehicles: Atlas V and Delta IV. We assessed the 14 different vehicle variants among these two families.

Source: © 2012 United Launch Alliance.

Concept | System development | Production

- Program start (12/96)
- Development/ production start (6/98)
- Design review (10/99)
- Medium-lift first flight (8/02)
- Heavy-lift first flight (12/04)
- Initial capability (12/06)
- Milestone recertification (2/13)
- GAO review (1/15)

Program Essentials

Prime contractor: United Launch Services, LLC
Program office: El Segundo, CA
Funding needed to complete:
R&D: $0.0 million
Procurement: $38,620.1 million
Total funding: $38,620.1 million
Procurement quantity: 94

Program Performance (fiscal year 2015 dollars in millions)

	As of 10/1998	Latest 12/2013	Percent change
Research and development cost	$1,885.8	$2,448.1	29.8
Procurement cost	$16,518.3	$58,916.3	256.7
Total program cost	$18,404.1	$61,364.4	233.4
Program unit cost	$101.680	$376.469	270.2
Total quantities	181	163	-9.9
Acquisition cycle time (months)	NA	120	NA

We assessed EELV technology as mature with 76 successful launches as of October 2014. EELV design and production maturity are not assessed using our best practices but using an Aerospace Corporation measure that was developed for the program. Using that measure, all 14 EELV launch vehicle variants have demonstrated technology maturity, 10 have demonstrated a stable design, and 3 have demonstrated production maturity. EELV has two ongoing engine-related efforts; development of a domestic booster and/or launch system as a potential alternative to the Russian-made RD-180 engine, and mitigation of an anomaly in an upper-stage engine. EELV realized approximately $4.4 billion in "should cost" savings from fiscal years 2012 through 2015 President's budgets and the program planned to award its first competitive national security launch service contract since 1998 in December 2014.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• *Complete preliminary design review*	
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

EELV Program

Technology, Design, and Production Maturity

All 14 EELV launch vehicle variants have flown at least once, demonstrating the viability of their technologies. However, there is significant disparity in design and production maturity among the variants. According to the Aerospace Corporation's measurement known as the "3/7 reliability rule," once a variant is launched successfully three times, its design can be considered mature. Similarly, if a variant is successfully launched seven times, both the design and production process can be considered mature. Based on this rule, only 3 of the 14 variants have reached maturity for both design and production. Ten variants have achieved design maturity and four variants have reached neither design nor production maturity. Some variants are used infrequently and may never reach design or production maturity. Until a variant demonstrates design and production maturity, problems with fleet-wide designs or production processes may go undiscovered, which could cause significant cost and schedule risk.

The program has current efforts to resolve difficulties with two separate engines. In August, the Air Force released a request for information for the development of a domestic booster propulsion and launch system as a potential alternative to the Russian-made RD-180 engine used on the Atlas V on which EELV currently relies for medium lift capability. The second effort is to resolve an anomaly in a Delta IV upper stage engine, which did not perform as expected during a launch in October 2012, but did place the satellite in its orbit. These engines have since functioned without incident on seven Delta IV launches. A contractor investigation determined that the anomaly resulted from a leak in a combustion chamber. The anomaly had no negative impact on the launch vehicle's or the engine's reliability, according to program officials. According to officials, EELV is taking steps to mitigate future risk on the upper stage engine, to include increased engine inspections and the installation of instruments to collect data on three upcoming flights. The contractor and Government concluded there is no systemic design risk in the engine.

Other Program Issues

In 2012, EELV reported critical Nunn-McCurdy unit cost breaches. Since then, the program has taken a variety of actions to reduce costs, and as a result, EELV realized approximately $4.4 billion in "should cost" savings from fiscal years 2012 through 2015, primarily due to instituting Better Buying Power initiatives such as economic order quantity purchasing, achieving better contract pricing, and taking into account the potential of future competition.

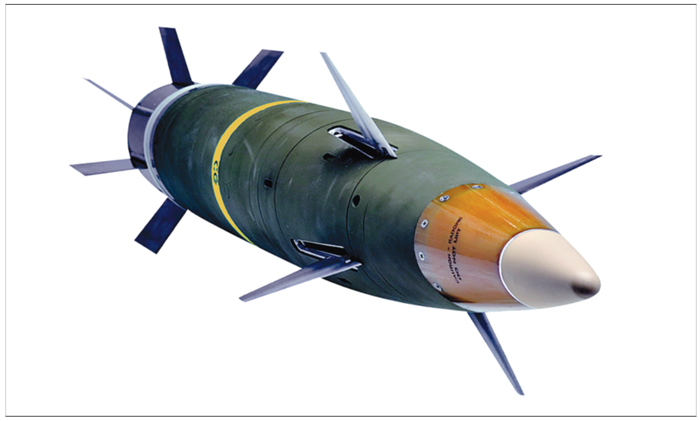
In December 2014, EELV planned to award its first competitive national security launch service contract in over 16 years. However, new launch providers must be certified by EELV prior to being eligible for a contract award and, to date, no potential new entrant has been certified. Multiple launch providers are currently working on the new entrant certification process, with projected certification dates ranging from late 2014 to late 2016. Space Exploration Technologies (SpaceX) launched its final certification flight in January 2014, and the Air Force is currently assessing launch data and other requirements to make a final determination. In April 2014, SpaceX also filed a lawsuit against the Air Force which included allegations regarding the December 2013 lot buy contract award.

Program Office Comments

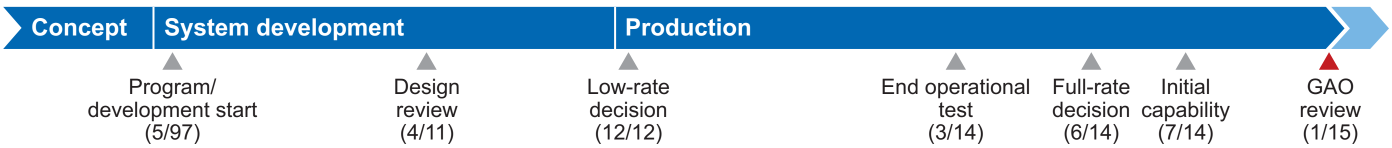
The Air Force provided technical comments, which were incorporated as appropriate.

Excalibur Precision 155mm Projectiles (Excalibur)

The Army's Excalibur is a family of global positioning system-based, fire-and-forget, 155mm cannon artillery precision munitions intended to provide improved range and accuracy. The near-vertical angle of fall is expected to reduce collateral damage, making it more effective in urban environments. The Army is using an incremental approach to deliver capabilities. Increment Ia-1 is fielded, Ia-2 is in production, and Ib, which is expected to increase reliability and lower unit costs, began production in 2012. We assessed increment Ib.



Source: U.S. Army.



Program Essentials

Prime contractor: Raytheon
Program office: Picatinny Arsenal, NJ
Funding needed to complete:
- R&D: $0.0 million
- Procurement: $76.5 million
- Total funding: $76.5 million
- Procurement quantity: 856

Program Performance (fiscal year 2015 dollars in millions)

	As of 02/2003	Latest 08/2014	Percent change
Research and development cost	$810.8	$1,143.7	41.1
Procurement cost	$4,248.3	$790.4	-81.4
Total program cost	$5,059.1	$1,934.1	-61.8
Program unit cost	$.066	$.259	292.2
Total quantities	76,677	7,474	-90.3
Acquisition cycle time (months)	NA	206	NA

The Excalibur program entered full-rate production with its critical technology mature and design stable. However, the program continues to make minor design changes to improve reliability and post-storage performance. Manufacturing processes for components unique to Ib were qualified through first article test and inspection, processes for components common to previous increments, and from existing vendors remained the same. The Ib round completed all recommended testing for insensitive munitions requirements and, according to program officials, initial results indicate that the round performs as expected. Increment Ib completed initial operational testing and was deemed operationally effective and reliable. The program's funding was at least partially restored in the fiscal year 2015 budget request, allowing completion of production without a quantity reduction.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• Demonstrate critical processes are in control	●
• Demonstrate critical processes on a pilot production line	●
• Test a production-representative prototype	●

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

Excalibur Program

Technology & Design Maturity

The Excalibur Increment Ib's sole critical technology—the guidance system—was fully mature and the system's design was stable at the start of full rate production in June 2014. The program, however, has made multiple incremental design changes intended to increase reliability since that time. For example, the base sub-assembly will use a mechanical seal instead of the previous glued foil seal, which, according to the program, should mitigate the risk of moisture intrusion and degraded performance. Additionally, the program has made changes to the Global Positioning System (GPS) receivers, due to a requirements change by the GPS directorate, that are expected to increase performance. We have previously reported on failures of the fuze safe and arm electronics, and, according to the program, it has implemented measures to make the electronics assemblies more rugged and increase margins for temperature cycles and long-term storage. We also previously reported that the Ib round did not meet requirements related to insensitive munitions—ensuring that a round will not detonate under any condition other than its intended mission. In the past year, however, the program completed all tests recommended by the Army Insensitive Munitions Board and states that preliminary results indicate that the increment Ib round performs as expected and to the latest testing standards. Official results are expected in the coming months.

Production Maturity

According to program officials, the production processes for Increment Ib are currently mature, as the majority of the manufacturing processes for the Ib round simply transitioned with components and vendors common to both Ia and Ib rounds. Unique Ib items, such as the global positioning system receiver, guidance electronics assembly, and guidance navigation unit, as well as common components from new vendors, were qualified through first article tests and inspections.

Other Program Issues

The program completed initial operational testing and evaluation in February 2014 and had completed three Ib production lot acceptance tests as of October 2014. Initial operational testing indicated that increment Ib is operationally effective and reliable, demonstrating the ability to engage more targets using fewer projectiles and at greater range than standard high-explosive projectiles. In addition, tests indicated that increment Ib achieved the required accuracy, even when subjected to global positioning jamming, and is more lethal against personnel and light material targets than standard high-explosive projectiles.

The program reported that current plans for fiscal year 2016 funding will restore production to previous levels of 3,455 Ib rounds concluding in fiscal year 2016. The program previously had its fiscal year 2013 procurement funding cut by $47.5 million due to a recommendation in the explanatory statement accompanying the Consolidated and Further Continuing Appropriations Act, 2013, as well as sequestration.

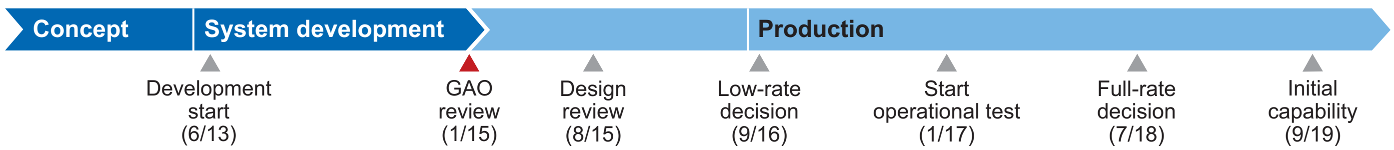
Program Office Comments

The Army was provided a draft of this assessment and did not offer any comments.

F-22 Increment 3.2B Modernization (F-22 Inc 3.2B Mod)

The Air Force's F-22 Raptor is a stealthy air-to-air and air-to-ground fighter/attack aircraft. The Air Force established an F-22 modernization and improvement program in 2003 to add enhanced air-to-ground, information warfare, reconnaissance, and other capabilities, and to improve the reliability and maintainability of the aircraft. Increment 3.2B, the fourth increment of the modernization program, was initially managed as part of the F-22 baseline program, but is now managed as a separate major defense acquisition program.

Source: U.S. Air Force.



Program Essentials

Prime contractor: Lockheed Martin
Program office: Wright-Patterson AFB, OH
Funding needed to complete:
R&D: $405.8 million
Procurement: $341.7 million
Total funding: $747.4 million
Procurement quantity: 143

Program Performance (fiscal year 2015 dollars in millions)

	As of 06/2013	Latest 08/2014	Percent change
Research and development cost	$1,238.0	$1,223.3	-1.2
Procurement cost	$349.1	$341.7	-2.1
Total program cost	$1,587.1	$1,564.9	-1.4
Program unit cost	$10.442	$10.296	-1.4
Total quantities	152	152	0.0
Acquisition cycle time (months)	72	75	4.2

Increment 3.2B is an enhancement to the F-22, bringing upgraded electronic protection, geolocation, and intra-flight data link capabilities, and integration of AIM-9X and AIM-120D missiles. The Air Force received approval to begin system development of Increment 3.2B as a separate major defense acquisition program in June 2013. The one reported critical technology has been demonstrated in a relevant, but not a realistic environment. Full technology and design maturity is expected by the critical design review in August 2015. The program has performed iterative software development in a laboratory environment, and has begun initial flight testing of software, according to program officials. Further delays in fielding earlier F-22 modernization increments could have an impact on fielding Increment 3.2, as the increments build upon each other.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

F-22 Inc 3.2B Mod Program

Technology and Design Maturity

Increment 3.2B is an enhancement to the F-22, bringing upgraded electronic protection, geolocation, and intra-flight data link capabilities, and integrating AIM-9X and AIM-120D missiles. The program's sole identified critical technology, a geolocation algorithm, is not yet fully mature, as it has been demonstrated in a relevant, but not a realistic environment. The program office expects the technology to reach full maturity by the critical design review, expected in August 2015. The Air Force also anticipates achieving a mature and demonstrated design by the critical design review, as 96 percent of system level drawings are currently releasable, and the program intends to conduct demonstrations with an integrated, system level prototype beginning in July 2015. According to a program official, initial flight testing of the software has already begun.

An F-22 program official acknowledged there is a test execution and data analysis risk to the program that, if not properly mitigated, would drive an aggressive test schedule. The program office is working with the contractor to develop a reasonable approach to mitigate the risk. Program officials also stated that the program has mitigated risk related to missile software development, and has reached an agreement with the AIM-9X program office on technical and schedule requirements for integrating the missile. The program office does not anticipate any impacts from the AIM-9X program in terms of cost increases or delays in schedule. The F-22 program office plans to field limited AIM-9X capabilities prior to the completion of Increment 3.2B by including them as part of an earlier software update.

Other Program Issues

Consistent with direction from Congress and the Office of the Secretary of Defense, the Air Force designated F-22 Increment 3.2B as a distinct major defense acquisition program rather than managing it as part of the F-22 baseline program. About half of the program's $1.2 billion estimated development cost was spent under the F-22 baseline program.

Longer than expected time frames for completing depot-level maintenance on F-22 aircraft extended the near-term F-22 modification schedule and could affect fielding of future modernization increments like 3.2B. Depot-level maintenance refers to major maintenance and repairs, such as overhauling, upgrading, or rebuilding parts, assemblies, or subassemblies, which is usually performed at a facility known as a depot. Fielding of modernization increments can take place at a depot, and program officials noted that the schedule for fielding Increment 3.1 has been affected due to depot-level delays. In May 2012, the Air Force expected Increment 3.1 to complete fielding in fiscal year 2016, but now will not complete until August 2017. Further delays may affect the time line for fielding future modernization increments as the increments build on each other. Increment 3.2A is a software upgrade that requires Increment 3.1 hardware, and delays in the Increment 3.1 schedule have caused the expected fielding completion of Increment 3.2A to move from fiscal year 2016 to fiscal year 2018. Similarly, any further delays in fielding these earlier increments could affect fielding of Increment 3.2B.

Program Office Comments

The Air Force provided technical comments, which were incorporated as appropriate.

F-35 Lightning II Program (F-35)

DOD's F-35 program is developing a family of stealthy, strike fighter aircraft for the Navy, Air Force, Marine Corps, and U.S. allies, with the goal of maximizing commonality to minimize life-cycle costs. The carrier-suitable variant will complement the Navy F/A-18E/F. The Air Force variant is expected to replace the air-to-ground attack capabilities of the F-16 and A-10, and complement the F-22A. The short take-off and vertical landing (STOVL) variant is expected to replace the Marine Corps F/A-18 and AV-8B aircraft.

Source: Courtesy of Lockheed Martin.

Concept | System development | Production

Program start	Development start	Design review	Production decision	Milestone recertification	GAO review	USMC initial capability	Start operational test	USAF initial capability	USN initial capability
(11/96)	(10/01)	(2/06 & 6/07)	(6/07)	(3/12)	(1/15)	(7/15)	(12/17)	(8/16)	(8/18)

Program Essentials

Prime contractor: Lockheed Martin, Pratt and Whitney
Program office: Arlington, VA
Funding needed to complete:
- R&D: $4,281.3 million
- Procurement: $232,730.1 million
- Total funding: $239,558.6 million
- Procurement quantity: 2,264

Program Performance (fiscal year 2015 dollars in millions)

	As of 10/2001	Latest 12/2013	Percent change
Research and development cost	$41,283.2	$62,000.1	50.2
Procurement cost	$183,154.4	$273,070.7	49.1
Total program cost	$226,354.8	$338,949.6	49.7
Program unit cost	$78.979	$137.953	74.7
Total quantities	2,866	2,457	-14.3
Acquisition cycle time (months)	116	237	104.3

Since starting development in 2001, the F-35 program has invested billions of dollars and procured 179 low-rate production aircraft for the United States. However, key gaps in product knowledge persist. One of the critical technologies—the aircraft prognostic and health management system—is not mature and the program continues to experience design changes. Developmental testing is progressing, but much of the testing remains, which will likely drive more changes. While manufacturing efforts remain steady, less than 40 percent of the program's critical manufacturing processes are mature—despite the 110 aircraft produced—and problems with the aircraft's engine have delayed aircraft deliveries and testing. Software development and testing remains a significant risk. Further delays in development may put future milestones at risk.

Attainment of Product Knowledge

As of January 2015

Knowledge point	Status
Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• Demonstrate critical processes are in control	○
• Demonstrate critical processes on a pilot production line	●
• Test a production-representative prototype	●

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

F-35 Program

Technology Maturity

Eight of the program's nine critical technologies are considered fully mature. The prognostics and health management system—part of the Autonomic Logistics Information System (ALIS) and critical to fleet operation and sustainment—is approaching maturity, but slower than expected software development has delayed its completion. The program made adjustments to the helmet mounted display to address performance shortfalls and determined that the current helmet's performance was sufficient for the Marine Corps' initial operational capability in 2015. The program is developing a next-generation helmet that will further enhance night vision and optical performance, and expects this expanded capability to be available in 2016 to support Air Force and Navy initial operational capability.

Design Maturity

Although the aircraft designs were not stable at their critical design reviews in 2006 and 2007, all baseline engineering drawings have since been released. However, issues discovered in testing continue to drive changes. For example, in 2013, the STOVL test aircraft developed multiple bulkhead cracks during durability testing. Program officials have identified the likely cause of the cracks and plan to incorporate design changes into future production. Fielded aircraft will be retrofitted during their normal scheduled maintenance. In addition, a critical part of the carrier variant's arresting hook system, the pivot pin, had to be redesigned. The new pin was tested during sea trials in November 2014. With nearly half of developmental testing remaining, the program faces the risk of further design changes.

Production Maturity

DOD plans to invest about $40 billion in procuring 179 U.S. aircraft through 2014. Aircraft manufacturing deliveries remain steady and the contractor has delivered 110 aircraft to date. The contractor uses statistical process controls as one means to assess critical manufacturing processes. Less than 40 percent of those processes are currently matured to best practice standards. In 2014, late software deliveries and fleet-wide groundings due to an engine fire delayed aircraft deliveries. In addition, part shortages further delayed aircraft deliveries and decreased production efficiency.

Other Program Issues

Software development and testing remains a key risk as software is critical to providing required capabilities. To achieve initial operating capability, the Marine Corps and Air Force will accept aircraft with the basic capabilities provided by software Blocks 2B and 3I respectively, while the Navy intends to wait for the full suite of capabilities provided by Block 3F. According to DOD officials, Block 2B development testing is currently about three months behind schedule. The program has pulled additional resources to focus on finishing 2B development and testing and made changes to their test plan, such as rescoping 2B operational testing. Although the program continues to experience delays, their fleet release dates have not been adjusted. Any delays experienced in development testing could put initial operational test and evaluation and full-rate production at risk. In June 2014, an aircraft engine caught fire just before take-off. This incident grounded the entire fleet for about one month, and resulted in flight restrictions and regular engine inspections. While a root cause analysis was conducted that identified a short-term fix to allow the resumption of testing, a final long-term solution has not yet been identified.

Program Office Comments

In addition to providing technical comments, the program office noted that it appreciates GAO's review in assisting the program by identifying areas for improvement. The program continues to make slow but steady progress and is executing across the entire spectrum of acquisition, including development, production, and operations and sustainment of fielded aircraft. The development program continues to execute to the baseline approved during the March 2012 Milestone B recertification. The biggest technical concern in development is still the timely delivery of software capability to the warfighter. The program implemented changes in how software is developed, tested, measured, and controlled. However challenges remain in speed and quality of software development. Other technical risks the program will continue to monitor are engine and aircraft durability, reliability and maintainability, reprogramming labs for the U.S. and our partners, and logistics information system maturity.

Family of Advanced Beyond Line-of-Sight Terminals (FAB-T)

The Air Force's FAB-T program plans to provide a family of satellite communications terminals for airborne and ground-based users to replace many program-unique terminals. Designed to work with current and future communications capabilities and technologies, FAB-T is expected to provide voice and data over military satellite communications networks for nuclear and conventional forces through ground command posts and E-6 and E-4 aircraft. It was originally planned to provide force element capabilities on B-2, B-52, and RC-135 aircraft also.

Source: U.S. Air Force.

Concept | **System development** | **Production**

- Development start (9/02)
- New development award (9/12)
- Design review (6/13)
- Development testing complete (3/15)
- GAO review (1/15)
- Low-rate decision (8/15)
- Full-rate decision (12/17)
- Initial capability (12/19)

Program Essentials

Prime contractor: Raytheon
Program office: Bedford, MA
Funding needed to complete:
R&D: $58.0 million
Procurement: $2,199.4 million
Total funding: $2,257.4 million
Procurement quantity: 222

Program Performance (fiscal year 2015 dollars in millions)

	As of 12/2006	Latest 07/2014	Percent change
Research and development cost	$1,628.1	$2,471.6	51.8
Procurement cost	$1,749.1	$2,286.0	30.7
Total program cost	$3,377.2	$4,757.7	40.9
Program unit cost	$15.635	$18.369	17.5
Total quantities	216	259	19.9
Acquisition cycle time (months)	129	207	60.5

The latest cost and quantity data do not reflect recent program decisions. A new acquisition program baseline has not yet been approved.

In 2012, after 10 years of continued cost and schedule growth developing FAB-T, the Air Force competed and awarded a contract to develop a new design for the program and, in June 2014 as a result of a down-select competition, the new contractor was selected for production. The new contractor's identified critical technologies and design are currently immature. Testing to fully demonstrate technologies in a realistic environment is expected to be completed prior to the program's planned low-rate production decision in August 2015. The cost and schedule baselines for FAB-T have not yet been updated to reflect the new contractor or other changes to the program strategy. An independent cost estimate that incorporates these changes is expected in July 2015.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	○
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	○
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

FAB-T Program

Technology and Design Maturity

In 2012, after 10 years of continued cost and schedule growth developing FAB-T, the Air Force competed and awarded a contract to develop a new design for the program and, in June 2014 as a result of a down-select competition, the new contractor was selected for production. In October 2014, the program completed a technology readiness assessment which identified five critical technologies for the new solution. None of these technologies were assessed as fully mature as they had not yet been tested in a realistic environment. Flight testing began in November 2014 and the program office expects to fully mature all technologies prior to the low-rate production decision in August 2015. Program officials stated that they expect testing to be completed by March 2015, but if tests are delayed or are unsuccessful, they will not proceed with a production decision until they are successful.

According to the program office, FAB-T's design for the first lot of low-rate production units is stable, but the program intends to use a new antenna for the second lot, which will result in design changes. Currently 85 percent of the engineering drawings for this final configuration have been released.

Production Maturity

The program's low-rate production decision is currently expected in August 2015, a delay of 11 months from our last review, most recently due to delays in completing hardware qualification and system level testing. As a result, the program expects delivery of its first terminals by September 2016. Program officials stated that the schedule for the production decision is contingent on the satisfactory completion of testing, an assessment of manufacturing readiness levels, an independent cost estimate, and a revised acquisition program baseline.

Other Program Issues

In 2012, FAB-T's acquisition strategy was changed to offer two possible production paths: one providing both command post and force element terminals, and the other providing only command post terminals. In December 2013, the Air Force decided to acquire only the 90 command post terminals. The 132 force element terminals are not currently funded, but program officials explained that they will remain part of the FAB-T program baseline until the Air Force decides how to meet this mission need. A new acquisition program baseline and independent cost estimate that reflect these changes and their projected costs will not be completed until 2015. If not integrated with the B-2 and B-52 bomber platforms, FAB-T may not meet its full range of planned communications capabilities as some are based on the interaction of bomber aircraft with intelligence, surveillance, and reconnaissance aircraft and command post terminals.

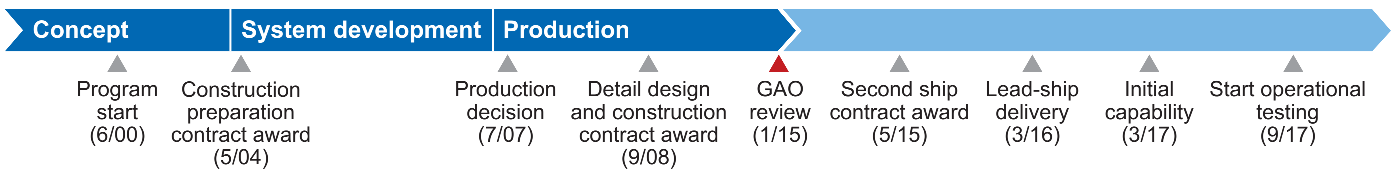
Program Office Comments

According to program officials, the FAB-T program continued to execute the revised acquisition strategy in 2014. The down-selected vendor made significant progress in development of the command post terminal in 2014. Software qualification tests are 100 percent complete with all 3,963 requirements passed. TEMPEST review, which is designed to protect information from foreign intelligence collection, is 100 percent complete with all 205 requirements passed. Contractor and government flight testing are complete. Software development and performance to date has exceeded the government's expectations. Formal physical and functional qualification tests are on-going. The independent cost estimate and the acquisition program baseline are being drafted to support Milestone C and will include updated costs, schedule, and quantity distributions to support the production phase of the program. The program also provided technical comments, which were incorporated as appropriate.

Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)

The Navy developed the Ford-class nuclear-powered aircraft carrier to serve as the future centerpiece of the carrier strike group. The lead ship, CVN 78, is over 80 percent complete and will introduce new propulsion, aircraft launch and recovery, weapons handling, and survivability capabilities to the carrier fleet. Early construction is underway for the first follow-on ship, CVN 79 and the Navy now expects to award the detail design and construction contract in the first half of 2015.

Source: U.S. Navy.



Program Essentials

Prime contractor: Huntington Ingalls Industries
Program office: Washington, DC
Funding needed to complete:
R&D: $404.5 million
Procurement: $15,977.0 million
Total funding: $16,401.1 million
Procurement quantity: 1

Program Performance (fiscal year 2015 dollars in millions)

	As of 04/2004	Latest 09/2014	Percent change
Research and development cost	$5,087.7	$4,903.1	-3.6
Procurement cost	$32,592.8	$31,314.7	-3.9
Total program cost	$37,680.5	$36,295.9	-3.7
Program unit cost	$12,560.151	$12,098.639	-3.7
Total quantities	3	3	0.0
Acquisition cycle time (months)	137	155	13.1

The Navy awarded a construction contract for CVN 78 in September 2008 when 5 of the ship's 13 critical technologies were mature and with only 65 percent of the ship's three-dimensional model complete. Since then, the lead ship's procurement costs have grown by almost 23 percent from $10.5 billion to $12.9 billion—the limit of the ship's current legislated cost cap—with four technologies still immature. The ship's critical technologies continue to experience developmental challenges, which poses risks to the ship's testing and delivery schedule. CVN 79 is also subject to a cost cap of $11.5 billion and its program office has adopted a new two-phased approach to construction to manage its costs. While this strategy may enable the Navy to meet the cost cap, it will also transfer some ship construction to the phase following delivery.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• Complete three-dimensional product model	●
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

CVN 78 Program

Technology and Design Maturity

The Navy reported 9 of CVN 78's 13 critical technologies are now fully mature, with the electromagnetic aircraft launch system (EMALS) fully maturing this year. Critical technologies are installed and shipboard testing is underway; land-based testing continues for EMALS, advanced arresting gear (AAG), and dual band radar (DBR). While EMALS has launched aircraft on land, it has not yet done so in a sea-based environment in its four-launcher configuration. Due to land-based testing failures, the Navy modified AAG's test strategy to ensure the ship begins flight deck certification in 2016. However, this approach means the system will begin arresting certain aircraft on CVN 78 before completing land-based testing on other aircraft types, risking discovery of new issues after ship delivery. The Navy is also unlikely to demonstrate full maturity of a DBR component radar until the completion of shipboard testing, scheduled to begin in January 2015. Further, the Navy will not install DBR on the follow-on ship (CVN 79) as planned, but intends to purchase an alternative radar at a lower cost. Given the concurrency in testing critical technologies, ship testing, and construction, CVN 78 risks further delays. For example, as a result of prior testing, the Navy implemented changes to the design of several key systems, including AAG, EMALS, and DBR. As construction progresses, the shipbuilder is also discovering "first-of-class" design changes, which it is using to update the design model to inform CVN 79 construction.

Production Maturity

With CVN 78 production over 80 percent complete, the shipbuilder appears to have resolved many of the challenges we noted in our September 2013 report. However, the lagging effect of these issues and a concurrent test program is creating a backlog of activities that threaten the ship's delivery date and could increase costs. Early construction is underway for the first follow-on ship, CVN 79 with about 20 percent of the ship's overall construction effort complete.

Other Program Issues

In 2007, Congress established a procurement cost cap of $10.5 billion for CVN 78. Since then, legislation increased the cost cap by almost 23 percent to $12.9 billion as the ship's procurement costs increased. Cost and analyses offfices in the Office of the Secretary of Defense estimated CVN 78's total cost could exceed the cost cap by $300-$800 million. Delivering CVN 78 under its cost cap depends on the Navy's plan to defer work and costs to the ship's post-delivery period—a strategy that could obscure true costs and likely result in delivery of an incomplete ship. To meet CVN 79's cost cap of $11.5 billion, the Navy is assuming unprecedented efficiency gains in construction by the shipbuilder and plans to adopt a new two-phased acquisition approach that will shift some construction after delivery. The Navy recently delayed the CVN 79 detail design and construction contract and extended the ship's construction preparation contract.

The Navy and DOD have not yet resolved whether a full ship shock trial will be required for CVN 78. Navy officials stated that DOD's Director, Operational Test and Evaluation has not approved the Navy's plan to defer this trial to CVN 79. According to the Navy, conducting this trial on CVN 78 would result in additional post-delivery costs and schedule delays. The Navy is awaiting a final determination by the Undersecretary of Defense for Acquisition, Technology and Logistics in March 2015.

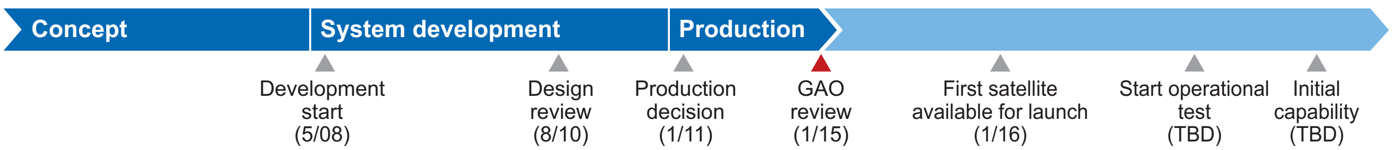
Program Office Comments

In addition to providing technical comments, the program office noted that the Navy is committed to completing CVN 78 and CVN 79 within their respective cost caps. The Navy and shipbuilder continue to take aggressive steps to control CVN 78 costs and drive affordability, as evidenced by stable cost performance over the past three years. Steps were taken to manage the shipboard test program to ensure cost performance remains stable. The Navy deferred some non-critical work not required at delivery to allow the shipbuilder to focus on critical activities to support delivery and provide the Navy the opportunity to complete work at a lower cost through competition. Deferred work cost is accounted for within the ship's end cost and thus is accounted for within the cost cap. For CVN 79, the Navy is executing a two-phase delivery strategy, whereby select system installations will occur in a Phase 2 construction period, minimizing obsolescence risk and increasing opportunity for competition. All costs for both phases of construction are included within the cost cap.

Global Positioning System III (GPS III)

The Air Force's Global Positioning System (GPS) III program plans to develop and field a new generation of satellites to supplement and eventually replace GPS satellites currently in use. Other programs will develop the ground system and user equipment. GPS III will be developed incrementally. We assessed the first increment, which intends to provide capabilities for a stronger military navigation signal to improve jamming resistance and a new civilian signal that will be interoperable with foreign satellite navigation systems.

Source: U.S. Air Force.



Program Essentials

Prime contractor: Lockheed Martin
Program office: El Segundo, CA
Funding needed to complete:
R&D: $244.8 million
Procurement: $220.4 million
Total funding: $465.2 million
Procurement quantity: 0

Program Performance (fiscal year 2015 dollars in millions)

	As of 05/2008	Latest 12/2013	Percent change
Research and development cost	$2,673.6	$2,961.6	10.8
Procurement cost	$1,501.1	$1,683.7	12.2
Total program cost	$4,174.7	$4,645.3	11.3
Program unit cost	$521.843	$580.668	11.3
Total quantities	8	8	0.0
Acquisition cycle time (months)	NA	NA	NA

We could not calculate acquisition cycle times for the first increment of the GPS III program because initial operational capability will not occur until satellites from a future increment are fielded.

Program officials reported that the GPS III program entered production in 2011 with all technologies assessed as mature, a stable design, and manufacturing processes in control. In addition, the program developed and tested a partial system-level prototype to reduce design and production risk. Design and technical problems with the mission data unit have been the primary contributors to the 21 month delay in the first satellite's availability for launch, now expected in January 2016. The program is currently rebaselining cost and schedule estimates due to this schedule breach. The greatest continuing risk to achieving the capabilities envisioned for the program is delays in GPS III's ground system, the first block of which is required to operate GPS III satellites and integrate them into the constellation.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• *Demonstrate all critical technologies in a realistic environment*	
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• Demonstrate critical processes are in control	●
• Demonstrate critical processes on a pilot production line	●
• Test a production-representative prototype	○

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

GPS III Program

Technology Maturity

The program office reports that all eight of its critical technologies are mature. However, the Air Force reported last year that it underestimated the technical challenge of the navigation payload, which includes five of the program's critical technologies. A key component of the navigation payload, the mission data unit, is described as the brain of the GPS III navigation mission. It experienced design and manufacturing problems that delayed the program by almost two years. The navigation payload has now been delivered, but it will be integrated onto the satellite bus and tested with a surrogate mission data unit.

Design and Production Maturity

The program office reports that the GPS III design is stable based on the number of design drawings released to manufacturing. Some design changes have been required to address problems identified in testing, such as those found on the mission data unit. GPS III program officials have stated that the design of the mission data unit was new, revolutionary, and highly complex, which contributed to its delay. To prove out production processes prior to integrating and testing the first space vehicle, the program tested a system-level integrated prototype that includes all key subsystems and components, but with less redundancy than the final configuration. The program office reported that development and testing of the prototype helped them identify problems earlier than they would have otherwise and to reduce the assembly time required for the first satellite. More issues may be identified during the remaining testing of the first satellite.

A complete GPS III satellite was not tested prior to the production decision nor has one been tested to date. At the time of GPS III's production decision in 2011, the program reported a level of manufacturing process maturity that indicated its processes were in control and production could begin.

Other Program Issues

The GPS III program is currently rebaselining cost and schedule estimates as it breached its acquisition program baseline schedule requirement for launch availability by nearly 2 years, primarily due to the late delivery of the mission data unit. The program now anticipates that the first satellite will be available for launch in January 2016. The new baseline may also reflect higher overall program costs due to GPS III cost growth to date, which the program office attributes to delays and increased material costs for both the satellite bus and navigation payload. The program office reports that the contract costs remain within the budget and the acquisition program baseline threshold.

At a recent review, the Under Secretary of Defense for Acquisition, Technology, and Logistics approved plans to place two additional space vehicles under contract and requested additional studies of all GPS programs, including GPS III's ground system, Next Generation GPS Operational Control System (OCX), and user equipment. Due to software development issues, GPS OCX has also incurred significant schedule delays. GPS III satellites cannot be integrated into the constellation or achieve operational availability until OCX Block 1 is delivered, currently planned for November 2018.

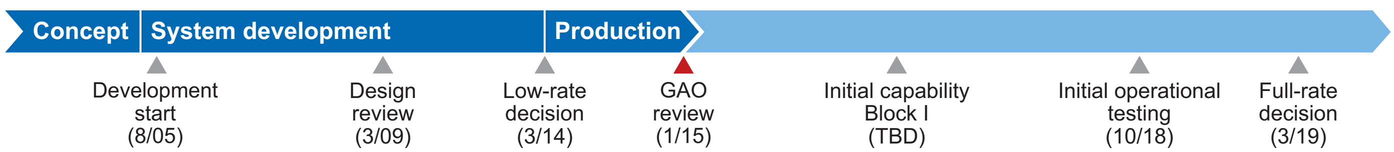
Program Office Comments

The program office concurred with this assessment and provided technical comments, which were incorporated.

Ground/Air Task Oriented Radar (G/ATOR)

The Marine Corps' Ground/Air Task Oriented Radar (G/ATOR) is an active electronic scanned array, three-dimensional, short-to-medium range, multi-role radar designed to detect cruise missiles, air breathing targets, rockets, mortars and artillery. It will replace five radars. G/ATOR is being acquired in blocks and later blocks are mostly software upgrades. GAO assessed Block I, which has an air defense and surveillance mission, and made observations on Block II, which will determine enemy firing positions and impact areas for incoming fire.

Source: U.S. Marine Corps.



Program Essentials

Prime contractor: Northrop Grumman
Program office: Quantico, VA
Funding needed to complete:
- R&D: $328.8 million
- Procurement: $1,510.9 million
- Total funding: $1,843.4 million
- Procurement quantity: 41

Program Performance (fiscal year 2015 dollars in millions)

	As of 08/2005	Latest 08/2014	Percent change
Research and development cost	$375.0	$1,033.6	175.6
Procurement cost	$1,177.6	$1,703.0	44.6
Total program cost	$1,552.6	$2,740.3	76.5
Program unit cost	$24.259	$60.895	151.0
Total quantities	64	45	-29.7
Acquisition cycle time (months)	66	TBD	TBD

The cost data includes G/ATOR Blocks I and II. The acquisition cycle time was calculated for Block 1 only.

The G/ATOR program received approval to enter production in March 2014 with mature technologies, a design refined for production, and production processes that had been demonstrated, but not in control. The program faces two main risks. In October 2014, an expert panel found that the G/ATOR's reliability requirements were likely unachievable and did not reflect operational needs. Software stability was the major reliability driver. The Marine Corps will revisit the reliability requirements and continue to address software issues during upcoming tests. The G/ATOR program will also transition to a new semiconductor technology in 2016. According to the program officials, this new technology is mature. Operational testing of G/ATOR units will not occur until 2018, at which point one-third of planned G/ATOR quantities will be under contract.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	○
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• Demonstrate critical processes are in control	○
• Demonstrate critical processes on a pilot production line	●
• Test a production-representative prototype	●

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

G/ATOR Program

Technology and Design Maturity

As of August 2014, G/ATOR reported that all six of its critical technologies were fully mature, and that the design had been refined for production. The program's design was stable at critical design review in 2009, but the number of total estimated drawings has increased as the program developed more detailed drawings to facilitate production. Currently, 89 percent of the refined set of drawings have been released. The program also continues to make software changes to address reliability issues and plans to upgrade the radar's transmit and receive modules in 2016. The program plans to upgrade the semiconductor technology used in these modules from gallium arsenide to gallium nitride. According to program officials, the gallium nitride technology is mature and the fit of the new modules will be the same as the old ones, which minimizes design changes. The gallium nitride technology is expected to achieve better performance at a lower cost by reducing the number of modules required.

The reliability of G/ATOR is improving, but the program is still addressing reliability issues. In June 2014, the Assistant Secretary of the Navy for Research, Development, and Acquisition chartered an expert panel to review the program's reliability requirements and assess the program's ability to achieve those requirements. The panel found that G/ATOR cannot achieve its current reliability requirements within the program's planned cost and schedule, and that the requirements did not reflect Marine Corps operational needs. The panel also found that the hardware for Block I units has matured and software stability was the major reliability driver. According to program officials, the Marine Corps will revisit G/ATOR's reliability requirement and the program will continue to make software improvements during upcoming tests. The reliability panel noted that the switch to gallium nitride should improve hardware reliability.

Production Maturity

The G/ATOR program received approval to enter production in March 2014 with production processes that had been demonstrated on a production line, but were not in control. Prior to its production decision, the program concluded that its manufacturing readiness reached the level recommended by DOD guidance, but not the level that indicated that processes were in control according to GAO's best practices.

Other Program Issues

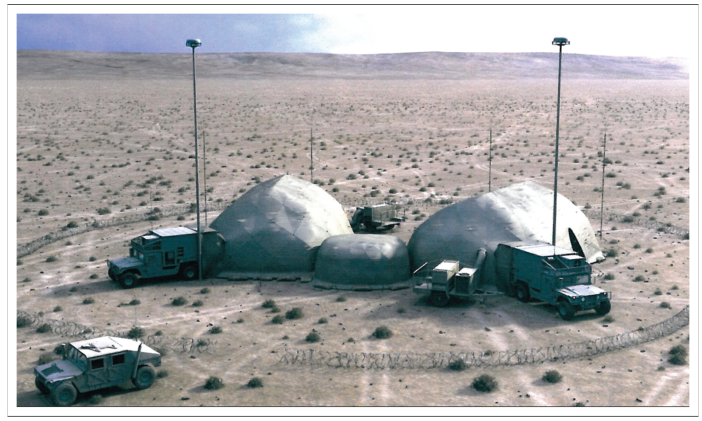
The G/ATOR program has a concurrent testing and production strategy which increases program risk. The program plans to concurrently perform testing on Block I, develop and test the Block II software, and perform low-rate initial production for Blocks I and II. The program plans to purchase a total of 15 low-rate initial production units, or one-third of the total funded units, before the initial operational test for Blocks I and II. The program originally planned to conduct operational testing earlier with the gallium arsenide configuration, but DOD's Director, Operational Test and Evaluation raised concerns about the production representativeness of this configuration because a majority of the planned G/ATOR procurements are with gallium nitride. Program officials said operational testing using gallium nitride will not occur until at least 2018 although test plans have not been finalized. The program has been conducting developmental testing using gallium nitride modules for two years.

Program Office Comments

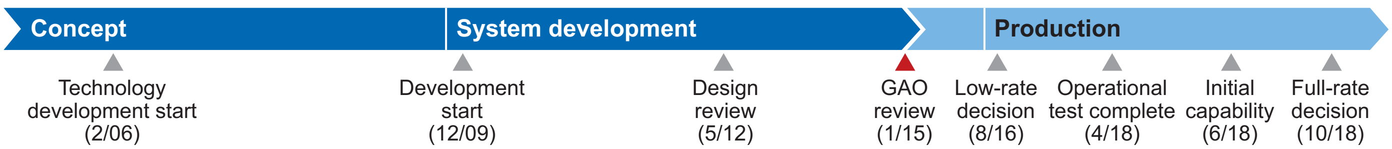
In commenting on a draft of this assessment, the program office noted that the G/ATOR program has remained on schedule and decreased the total estimated program cost since it was rebaselined in 2010. It reported an overall reduction of 14.7 percent in estimated cost since 2012 as a result of implementing Better Buying Power 2.0 and aggressively pursuing "should cost" initiatives. According to officials, the G/ATOR program went through extensive reviews and analyses to validate production readiness before authorization to enter low rate production, resulting in a contract award in October 2014. The program office also stated that it continues to refine the system software required in 2017, when low rate production hardware is delivered, to improve system reliability. It also noted that the expert panel identified above stated the G/ATOR hardware is extremely stable and robust. Technical comments were provided by the program office, which were incorporated where deemed appropriate.

Integrated Air and Missile Defense (IAMD)

The Army's Integrated Air and Missile Defense (IAMD) program is being developed to network sensors, weapons, and a common battle command system across an integrated fire control network to support the engagement of air and missile threats. The IAMD battle command system will provide a capability to control and manage IAMD sensors and weapons, such as the Sentinel radar and Patriot launcher and radar, through an interface module that supplies battle management data and enables networked operations.



Source: Northrop Grumman.



Program Essentials

Prime contractor: Northrop Grumman Space & Mission Systems Corp, Raytheon Integrated Defense Systems
Program office: Redstone Arsenal, AL
Funding needed to complete:
- R&D: $992.4 million
- Procurement: $3,682.8 million
- Total funding: $4,675.2 million
- Procurement quantity: 427

Program Performance (fiscal year 2015 dollars in millions)

	As of 12/2009	Latest 10/2014	Percent change
Research and development cost	$1,689.4	$2,412.0	42.8
Procurement cost	$3,636.4	$3,481.5	-4.3
Total program cost	$5,325.8	$5,893.5	10.7
Program unit cost	$17.993	$13.185	-26.7
Total quantities	296	447	51.0
Acquisition cycle time (months)	80	102	27.5

IAMD technologies are approaching full maturity and at least 90 percent of its design drawings have been released. However, the program has encountered software integration and synchronization challenges. According to program officials, a software development re-plan approved in early 2013 established incremental deliveries to mitigate these challenges. The program reported a baseline schedule breach in June 2014 due to budget reductions and the decision to defer initial operational capability by two years. While this delays the delivery of capability to the warfighter, program officials believe it reduces integration risk prior to flight tests and aligns the program with other related air and missile defense programs.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

IAMD Program

Technology Maturity

IAMD's four critical technologies—integrated battle command, integrated defense design, integrated fire control network, and distributed track management—are not expected to be fully mature until the program's low rate initial production decision in August 2016. The program entered system development in 2009 with these technologies assessed as approaching full maturity based on a notional design.

Design Maturity

According to program officials, IAMD is dependent on other acquisition programs to deliver components and conduct testing, and, as system integrator, the program must coordinate other programs' priorities and changes to ensure synchronization. Although the program reports that 92 percent of the expected design drawings have been released, it has encountered challenges integrating and synchronizing new software from the contractor with the other acquisition programs IAMD relies on for its functionality. To reduce integration risks, the program approved a software development re-plan in April 2013, which established an incremental delivery schedule and updated software size estimates. Program officials now estimate the size of the software development effort at 4.5 million lines of code. Approximately 3 million lines of code are auto-generated code which, according to program officials, require less effort to develop than newly developed or modified code. In August 2014, the Army shipped equipment to White Sands Missile Range to begin preparations for the first of four development flight tests scheduled to begin in May 2015. The Army expects to have sufficient test equipment and personnel to support testing before the initial production decision and is ensuring Patriot resources are available for developing, testing, and integrating software.

Other Program Issues

According to program officials, the software challenges, coupled with fiscal year 2015 budget reductions, led to a deferment of a number of key events which triggered a schedule breach of the acquisition program baseline. The program's production decision and the completion of initial operational test and evaluation slipped by over a year and are now expected to occur in August 2016 and April 2018, respectively. Initial operational capability is now expected in June 2018, a slip of nearly 2 years. According to program officials, these delays reduce integration risk for the program and will improve IAMD's alignment with other related air and missile defense programs. For example, officials currently do not foresee a risk in integrating the Warfighter Information Network-Tactical. A new acquisition program baseline reflecting these changes was approved in October 2014.

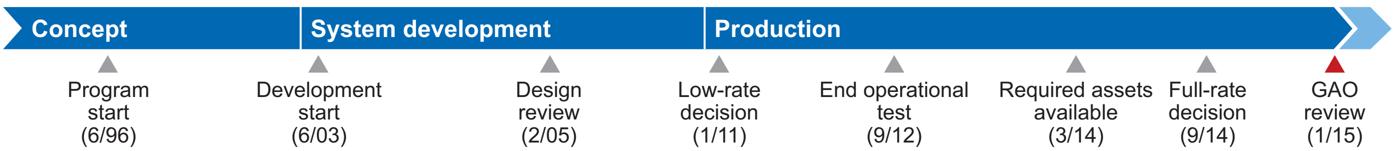
Program Office Comments

The program office was provided a draft of this assessment and did not offer any comments.

Joint Air-to-Surface Standoff Missile Extended Range (JASSM-ER)

The Air Force's JASSM-ER program has begun fielding a next-generation cruise missile capable of destroying the enemy's war-sustaining capability from outside its air defenses. JASSM-ER is designed to be low-observable, subsonic, and have a range greater than 500 miles. They provide both fighter and bomber crews the ability to strike heavily defended targets early in a campaign. JASSM-ER is a follow-on program to the JASSM baseline program. The two missiles' hardware is 70 percent common and their software is 95 percent common.

Source: U.S. Air Force.



Program Essentials

Prime contractor: Lockheed Martin
Program office: Eglin AFB, FL
Funding needed to complete:
- R&D: $65.2 million
- Procurement: $3,300.5 million
- Total funding: $3,365.6 million
- Procurement quantity: 2,686

Program Performance (fiscal year 2015 dollars in millions)

	As of 04/2011	Latest 07/2014	Percent change
Research and development cost	$173.1	$298.2	72.3
Procurement cost	$2,214.9	$3,613.0	63.1
Total program cost	$2,387.9	$3,911.2	63.8
Program unit cost	$.953	$1.359	42.7
Total quantities	2,507	2,877	14.8
Acquisition cycle time (months)	NA	129	NA

The JASSM-ER was approved to enter full rate production in September 2014 with its critical technologies mature, a stable design, and mature manufacturing processes in statistical control. However, the program plans to redesign the engine lubrication pump to allow for production efficiencies. Although the program was successful in resolving production issues with the fuel control unit, it also encountered new production issues in fiscal year 2014 with the engine heat shields. Further, as the program enters full-rate production, it must contend with a backlog of over 250 baseline variant missiles in need of warranty repairs while producing new extended range missiles. The program is failing to meet its materiel availability requirement for baseline missiles, as program officials expect it will take at least four years to fix all the missiles in need of repairs.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	▪▪▪▪
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• Demonstrate critical processes are in control	●
• Demonstrate critical processes on a pilot production line	●
• Test a production-representative prototype	●

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

JASSM-ER Program

Technology and Design Maturity

According to the program office, JASSM-ER's five critical technologies—the engine lube system, engine system, fuze, low observable features, and global positioning system—are mature and have been tested in a realistic environment using a production-representative test missile. JASSM-ER's design is stable and has been successfully demonstrated in operational tests. The program has accepted an engineering change proposal from the engine manufacturer to redesign the extended range variant's engine lubrication pump for production efficiencies. The implementation of the design change is proceeding through qualification testing, and production will begin with the third lot of the extended range missile's low-rate initial production in 2015.

Production Maturity

In fiscal year 2014, the JASSM-ER program was successful in resolving production issues with the fuel control unit, which allowed for missile deliveries to begin. Lockheed Martin, the program's prime contractor, delivered the first lot of extended range missiles—30 in total—and began production on the second lot. Final delivery of the first lot of low-rate initial production missiles in March 2014 allowed the program to successfully meet its requirement for operational deployment. In September 2014, the program received authorization to proceed to enter full-rate production after completion of all four low-rate initial production lots.

Although the program reports having mature production processes and achieved significant progress in fiscal year 2014, it also encountered new production issues. For example, the program failed two extended range engine acceptance tests during low-rate production of the second lot. The program determined that substandard welding in the engine's heat shield caused cracks to form during testing, generating excessive engine vibration. According to program officials, the first lot of engines was not affected but several fully assembled extended range missiles from the second lot had to be disassembled to correct the issue. All affected engines were reworked, re-tested, and delivered back to Lockheed Martin for final assembly. According to the program office, the engine re-work was completed in time for Lockheed Martin to meet their contractual delivery date.

Other Program Issues

As the program enters full-rate production, it will have to simultaneously fix baseline variant missiles that are in need of warranty repair while producing new extended range missiles. Although the program is currently meeting its materiel availability requirement for extended range missiles, it is failing the requirement for baseline missiles, as over 250 are currently awaiting warranty repairs at Lockheed Martin. Most of these missiles require repair due to a faulty exterior coating that was used on the first 240 baseline missiles produced, according to program officials. The backlog was increased in fiscal year 2014 by an issue discovered with the seeker lens assembly on 35 baseline missiles. Although Lockheed Martin has begun repairs, program officials expect it will take at least four years to complete. The program office has notified Lockheed Martin that it intends to withhold a portion of all payments on Lots 10 through 12 should they complete less than 24 repairs per quarter. An improved coating was developed to address the issue, which was used for extended range missile production.

Program Office Comments

In commenting on a draft of this assessment, the Air Force provided technical comments, which were incorporated where deemed appropriate.

Joint Light Tactical Vehicle (JLTV)

The Army and Marine Corps' JLTV is a family of vehicles being developed to replace the High Mobility Multipurpose Wheeled Vehicle (HMMWV) for some missions. The JLTV is expected to provide better protection for passengers against current and future battlefield threats, increased payload capacity, and improved automotive performance over the up-armored HMMWV. It must also be transportable by air and ship. Two- and four-seat variants are planned with multiple mission configurations.

Source: JPO JLTV EMD Industry Contractors (AM General, Oshkosh Corp. & Lockheed Martin).

Concept | **System development** | **Production**

- Program start (12/07)
- Development start (8/12)
- Design review (1/13)
- GAO review (1/15)
- Low-rate decision (7/15)
- Begin operational test (7/17)
- Full-rate decision (2/18)
- Initial capability (8/18)

Program Essentials

Prime contractor: AM General, Lockheed Martin, Oshkosh
Program office: Harrison Township, MI
Funding needed to complete:
R&D: $254.2 million
Procurement: $22,752.6 million
Total funding: $23,006.8 million
Procurement quantity: 54,599

Program Performance (fiscal year 2015 dollars in millions)

	As of 10/2012	Latest 12/2013	Percent change
Research and development cost	$1,008.3	$975.0	-3.3
Procurement cost	$22,822.7	$22,752.6	-0.3
Total program cost	$23,868.6	$23,727.6	-0.6
Program unit cost	$.436	$.434	-0.6
Total quantities	54,730	54,730	0.0
Acquisition cycle time (months)	125	128	2.4

Both JLTV critical technologies—underbelly protection armor and side-kit armor—are fully mature and, according to program officials, have been integrated and tested on production-representative vehicles. The government has completed a design understanding review and production readiness review with all three contractors to assess their technical baseline and manufacturing readiness levels. While reliability, availability, and maintainability testing has been completed, the program office has not received full test results. However, program officials state there are no anticipated changes to requirements as a result of this testing. The Army released a request for proposals for low- and full-rate production in December 2014 and an award is scheduled for July 2015.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	....
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

JLTV Program

Technology Maturity

According to the program office, its two critical technologies—underbelly protection armor and side-kit armor—are fully mature. Early technology maturity challenges stemmed from integration of existing materials that meet weight requirements, and not necessarily in development of unique materials. According to Army officials, prototype systems with integrated armor technologies have been tested in a realistic environment, although results were not yet available for our review. Consequently, the Army has declared both technologies mature and demonstrated under operational conditions.

Design Maturity

The program office did not hold a formal critical design review during development and instead conducted design understanding reviews with contractors between December 2012 and January 2013. According to program officials, these reviews were at a level of detail similar to a critical design review and were held to support the requirement for mature vehicle designs at the time of contractor award for system development. This review verified that all contractors had more than 90 percent of the design files under configuration control. In May 2014, officials responsible for JLTV requirements oversight recommended that one of the two protection levels under consideration be eliminated from the requirements. Previously, there were two add-on armor configurations planned to address the different protection levels desired by the Army and Marine Corps. According to program officials, the Army and Marine Corps will now both use the higher protection level configuration, which could reduce live-fire testing by 40 percent and save up to $20 million.

Production Maturity

According to the Army, the low number of vehicles produced during system development would not allow for statistically relevant measurements and thus precludes the use of process capability index data. Instead, the program conducted a manufacturing readiness assessment and used manufacturing readiness levels to assess production readiness and manufacturing risks. In August and September of 2014, the program held production readiness reviews for the three competing contractors to examine manufacturing process readiness, quality management systems, and production planning. The Joint Program Office has completed the review and released the low- and full-rate production request for proposals in December 2014.

Other Program Issues

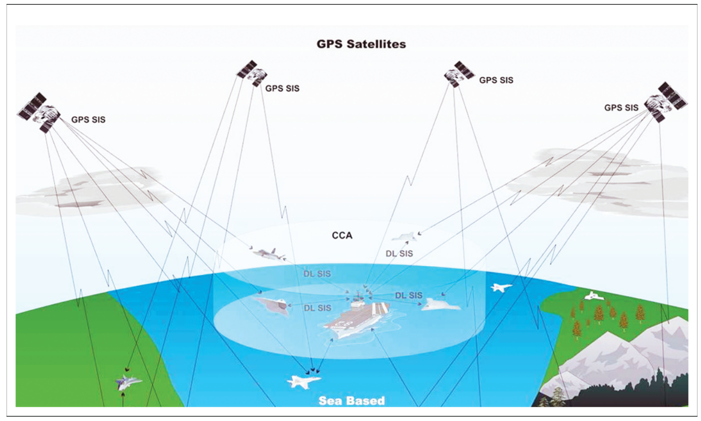
In June 2014, the program completed its planned final critical program review for the system development phase. Although each development contractor identified a level of performance non-compliance, the acquisition strategy and recently-released request for proposals allow the potential low- and full-rate production vendors to make some trades to maximize performance within government cost thresholds. A proposal will not be considered for award if the level of performance offered is below the requirements threshold value.

Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

Joint Precision Approach and Landing System Increment 1A (JPALS Inc 1A)

JPALS Increment 1A is a Navy-led program to develop a GPS-based landing system for aircraft carriers and amphibious assault ships to support operations with Joint Strike Fighter and Unmanned Carrier-Launched Airborne Surveillance and Strike System. The program intends to provide reliable precision approach and landing capability in adverse environmental conditions. We assessed increment 1A, and as a result of restructuring, previously planned additional increments are no longer part of the program.



Source: U.S. Navy.

Concept | **System development** | **Production**

- Development start (7/08)
- GAO review (1/15)
- Restructured development start (6/16)
- Restructured design review (3/17)
- Restructured low-rate decision (3/19)
- Initial capability (TBD)

Program Essentials

Prime contractor: Raytheon
Program office: Lexington Park, MD
Funding needed to complete:
R&D: $641.5 million
Procurement: $525.8 million
Total funding: $1,167.3 million
Procurement quantity: 17

Program Performance (fiscal year 2015 dollars in millions)

	As of 07/2008	Latest 08/2014	Percent change
Research and development cost	$838.9	$1,563.6	86.4
Procurement cost	$225.8	$504.2	123.2
Total program cost	$1,072.1	$2,075.1	93.6
Program unit cost	$28.976	$76.857	165.2
Total quantities	37	27	-27.0
Acquisition cycle time (months)	75	TBD	TBD

The latest cost data do not reflect the June 2014 restructuring of the program as a new acquisition program baseline has not been approved.

JPALS Increment 1A began development in July 2008, and both of the program's currently identified critical technologies were demonstrated in a realistic environment during flight testing in 2013. Program officials reported completing baseline software development as of April 2012. The program began system-level development testing in July 2012 and sea-based testing in December 2012, completing 108 approaches as of July 2013 with no major anomalies reported. According to program officials, no critical manufacturing processes have been identified as JPALS relies primarily on off-the-shelf components. In March 2014, the JPALS program reported a critical Nunn-McCurdy unit cost breach and a new cost and schedule baseline is currently being developed.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

JPALS Inc1A Program

Technology, Design, and Production Maturity

In June 2014, the JPALS program was restructured to accelerate the development of aircraft auto-land capabilities. The program's technology and design maturity will need to be reassessed to account for this alteration of capabilities, and the program has not yet determined what changes are required.

Prior to this restructuring, the program had completed a number of activities to mature its technology and design. JPALS Increment 1A began development in July 2008, and, according to program officials, the two currently identified critical technologies were demonstrated in a realistic environment during sea-based flight testing in 2013. JPALS functionality is primarily software-based, and the program's baseline software development and integration efforts were complete as of April 2012. JPALS Increment 1A held a critical design review in December 2010 and released its all of its expected design drawings at that time. The program began testing a system-level prototype in July 2012, 19 months after its critical design review. Sea-based testing of the system in its current configuration began in December 2012, and program officials reported completing 108 approaches as of July 2013, with no major anomalies identified. The program also completed 70 ship-based auto-landing demonstrations using legacy aircraft as of November 2013. According to JPALS officials, the Increment 1A program has not identified any critical manufacturing processes, as the system's hardware is comprised primarily of off-the-shelf components. The program has accepted delivery of eight engineering development models, seven of which were considered production-representative.

Other Program Issues

In 2013, the Navy conducted a review of its precision approach and landing capabilities to address budget constraints and affordability concerns. In light of these concerns, as well as other military service and civilian plans to continue use of current landing systems, the Navy restructured the JPALS program. The program was reduced from seven increments to one intended to support the Joint Strike Fighter and Unmanned Carrier-Launched Airborne Surveillance and Strike System. The Navy also accelerated the integration of auto-land capabilities originally intended for the future increments, and eliminated both the integration of JPALS with other sea-based legacy aircraft and the land-based version of the system. These changes increased the development funding required for auto-land capabilities and reduced system quantities, resulting in unit cost growth and a critical Nunn-McCurdy unit cost breach reported in March 2014. The Under Secretary of Defense for Acquisition, Technology, and Logistics certified the restructured program and directed the Navy to continue risk reduction efforts to incorporate the auto-land capabilities and return for a new development start decision no later than June 2016. The Navy plans to conduct a preliminary design review for the new system in fiscal year 2016 and a critical design review in fiscal year 2017.

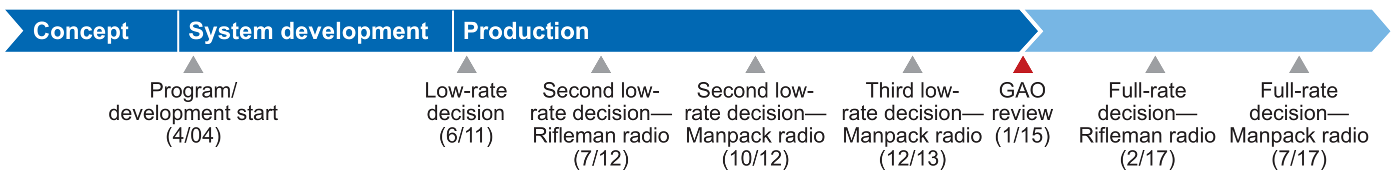
Program Office Comments

In commenting on a draft of this assessment, the program noted that it concurred with our review. The Nunn-McCurdy unit cost breach was a direct result of a reduction in quantities and an acceleration of auto-land capability into the JPALS baseline. The quantity reduction was due to changes in the planned transition to GPS-based landing systems. The Navy decided to terminate both JPALS legacy aircraft integration efforts and ground based systems, and accelerate auto-land capabilities to meet Joint Strike Fighter and Unmanned Carrier-Launched Airborne Surveillance and Strike System requirements. The Joint Strike Fighter will utilize JPALS interim capability as part of its Block 3F software, and the Unmanned Carrier-Launched Airborne Surveillance and Strike System will utilize JPALS as a baseline capability for its precision approach landing requirement. The restructured JPALS eliminates future incremental development.

Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios (JTRS HMS)

DOD's JTRS program is developing software-defined radios that will interoperate with existing radios and increase communications and networking capabilities. The JTRS HMS program is currently developing two radios: the Rifleman radio and the Manpack radio. A subset of the Manpack radios will be interoperable with the Mobile User Objective System (MUOS), a satellite communication system.

Source: © 2012 General Dynamics C4S.



Program Essentials

Prime contractor: General Dynamics C4 Systems, Inc.
Program office: Aberdeen Proving Ground, MD
Funding needed to complete:
  R&D: $161.3 million
  Procurement: $7,906.8 million
  Total funding: $8,068.0 million
  Procurement quantity: 230,347

Program Performance (fiscal year 2015 dollars in millions)

	As of 05/2004	Latest 12/2013	Percent change
Research and development cost	$576.9	$1,394.4	141.7
Procurement cost	$10,054.6	$8,969.1	-10.8
Total program cost	$10,631.5	$10,363.5	-2.5
Program unit cost	$.032	$.038	18.1
Total quantities	328,674	271,202	-17.5
Acquisition cycle time (months)	85	122	43.5

The JTRS HMS program has not demonstrated all critical technologies in a realistic environment. Additionally, the Manpack variant has not yet met its reliability requirement. Reliability shortfalls were identified during operational testing conducted in May 2014. In 2013, soldiers concluded the Rifleman variant was not yet acceptable for combat and additional operational testing is planned for fiscal years 2016 and 2017. Since last year's assessment, the full-rate production decisions for both Manpack and Rifleman slipped by nearly two additional years. Program officials attributed this recent delay to getting the program's revised acquisition strategy approved after it was directed to conduct a full and open competition for both variants' full-rate production contracts.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• Demonstrate critical processes are in control	●
• Demonstrate critical processes on a pilot production line	○
• Test a production-representative prototype	●

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

JTRS HMS Program

Technology Maturity

Despite conducting operational tests over the last three years, the program office reports it has not yet demonstrated all the critical technologies for both the Rifleman and Manpack radios in a realistic environment, primarily due to failures in those tests. Additional testing for both variants is expected in fiscal year 2016 and fiscal year 2017, respectively.

Design and Production Maturity

According to program officials, the designs of both variants are stable, but reliability issues for could require future design modifications. Following operational testing in May 2012, DOD test officials reported that the Manpack was not operationally effective or suitable because it failed to demonstrate a reliability requirement. Despite efforts to address reliability shortfalls, follow-on testing in May 2014 determined that the Manpack still did not meet its reliability requirement. Additional testing is now scheduled for the first quarter of fiscal year 2017. Following a May 2013 test, soldiers concluded that the Rifleman variant was not yet acceptable for combat due to performance issues. For example, it spontaneously rebooted, and took excessive time to rejoin the network. Additional operational testing for the Rifleman is now scheduled for the middle of fiscal year 2016.

Other Program Issues

Both variants of JTRS HMS have experienced additional schedule slips since last year's assessment. The full rate production decisions for Rifleman and Manpack have slipped by nearly two additional years to February 2017 and July 2017, respectively. According to program officials, this further delay is a result of the longer than expected period to get the program's acquisition strategy approved after the Office of the Secretary of Defense directed JTRS HMS to conduct full and open competition for the full-rate production contracts for both variants. The revised acquisition strategy was approved by the Under Secretary of Defense for Acquisition, Technology and Logistics in May 2014. Since the program's low rate initial production decision in June 2011, both variants' full rate production decisions have continually slipped each year. Collectively, the expected full rate production decisions are nearly five years later than expected. The repeated slips have come among poor test results, but program officials have attributed recent slips to the requirement for a full and open competition. Prior to the full-rate production decisions, the program must solicit proposals from new vendors and, according to program officials, will likely award new contracts and test new radios.

The program's schedule for fielding the MUOS-capable Manpack radio has also slipped since last year's assessment. The program was scheduled to field these radios in 2014, but now it is unlikely the program will do so until 2016. Program officials have stated that they will wait to demonstrate the Manpack with the MUOS antenna and waveform until after the MUOS program successfully completes its own operational testing, which has experienced delays.

Program Office Comments

In commenting on a draft of this assessment, the program noted that the Army released a request for proposals in January 2015 to procure additional Rifleman Radios, using a full and open competition. The program also noted that indefinite delivery indefinite quantity (IDIQ) full-rate production contracts will be awarded to multiple vendors who meet the technical requirements. The contracts will have a five year base ordering period with an optional five year ordering period. The Army intends to conduct competitions for delivery orders among the IDIQ contract holders. By early 2015, more than 19,000 Rifleman Radios from low rate initial production lots have been delivered and are in use by Army brigade combat teams, having been successfully used in a variety of overseas operations. The program office also provided technical comments, which were incorporated as appropriate.

KC-46 Tanker Modernization Program (KC-46A)

The Air Force's KC-46 program plans to convert an aircraft designed for commercial use into an aerial refueling tanker for Air Force, Navy, Marine Corps, and allied aircraft. The program is the first of three planned phases to replace the Air Force's aging aerial refueling tanker fleet. The KC-46 has been designed to improve on the KC-135's refueling capacity, efficiency, and capabilities for cargo and aeromedical evacuation, and to integrate defensive systems.

Concept | System development | Production

- Development start (2/11)
- Critical design review (7/13)
- GAO review (1/15)
- KC-46 first flight (4/15)
- Low-rate decision (10/15)
- Start operational test (10/16)
- Full-rate decision (6/17)
- Required assets available (8/17)

Program Essentials

Prime contractor: Boeing
Program office: Wright-Patterson AFB, OH
Funding needed to complete:
R&D: $1,674.1 million
Procurement: $33,684.5 million
Total funding: $37,881.8 million
Procurement quantity: 175

Program Performance (fiscal year 2015 dollars in millions)

	As of 02/2011	Latest 07/2014	Percent change
Research and development cost	$7,257.0	$6,700.5	-7.7
Procurement cost	$35,239.2	$33,684.5	-4.4
Total program cost	$46,414.5	$43,159.4	-7.0
Program unit cost	$259.299	$241.114	-7.0
Total quantities	179	179	0.0
Acquisition cycle time (months)	78	78	0.0

One of KC-46's three critical technologies is fully mature, and the other two are expected to be mature by its low-rate production decision in 2015. After the critical design review, the program had wiring design changes that led to several delays, including at least a three month delay to KC-46 first flight. The program does not plan to demonstrate a full system-level prototype until April 2015, 21 months after its critical design review. Boeing is manufacturing four development aircraft, but its suppliers are not delivering aerial refueling systems on time. Program officials said they plan to verify that certain suppliers have procedures in place to collect process control data, but do not plan on analyzing that data to ensure processes are in control by low-rate production. The program is currently revising its test strategy and schedule to account for recent delays.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	○
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

KC-46A Program

Technology Maturity

The program office has identified three technologies as critical for KC-46, two modules of software related to situational awareness and a three-dimensional display that allows the crew to monitor aerial refueling activities. Currently, only one of these three critical technologies—one of the software modules—is mature. The other two technologies are nearing full maturity, having been tested in a relevant environment. The program plans to fully mature all technologies through laboratory and flight testing by the low-rate production decision.

Design and Production Maturity

At its critical design review, the program had released over 90 percent of its design drawings. Since that time, some problems were discovered with the wiring of the commercial aircraft that delayed progress towards testing and production. Boeing began rewiring the first development aircraft before fully wiring the remaining three aircraft currently in production.

In addition, key suppliers have continued to experience difficulties with the design and manufacture of aerial refueling systems, such as refueling booms and wing aerial refueling pods. The boom that was to be installed on the first KC-46 has been delayed by eight months due to design changes and late parts deliveries. Another supplier has experienced significant delays in manufacturing wing aerial refueling pods for qualification testing and development aircraft due, in part, to challenges with parts delays and engineering design changes. As a result of these delays, first flight of an aircraft that integrates military sub-systems has slipped at least three months to April 2015, 21 months after critical design review. Best practices call for completing a full system-level prototype demonstration by the critical design review in order to show that the design is capable of meeting performance requirements.

The program office and Boeing have taken several initial steps to capture necessary manufacturing knowledge, such as using manufacturing readiness levels to assess risk. Program officials said that while they plan on verifying that military sub-system suppliers have procedures in place to collect process control data, they do not plan on analyzing that data to ensure these processes are in control by low-rate production as recommended by best practices.

Other Program Issues

To offset the effect of the wiring delays, Boeing and the program office are in the process of revising the flight test strategy and schedule, and officials expect to finalize it in early 2015. According to program officials, KC-46 will still have enough time to complete the testing required for the low-rate production decision, but will likely complete less testing than originally planned. The program has also encountered software integration challenges. Although all software has been delivered, Boeing is encountering more than twice the number of software problems than originally estimated that prevent or adversely affect the accomplishment of an essential operational or test capability. As a result, Boeing delayed the start of the laboratory verification testing needed to demonstrate the defensive and aerial refueling software by more than two months.

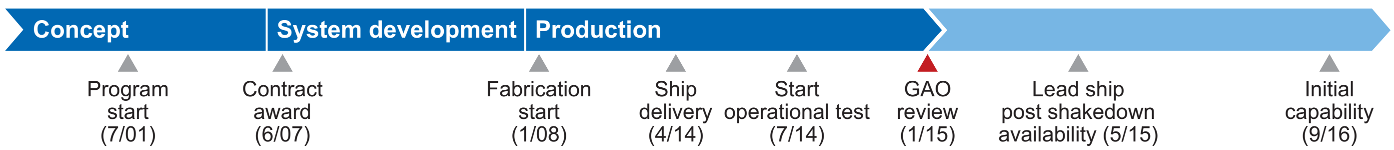
Program Office Comments

In commenting on a draft of this assessment, the program office noted that it has mitigated financial risk with the competitive fixed-price incentive development contract with firm-fixed and not-to-exceed pricing for the production of the aircraft. More than 57 percent of the development work has been completed. Boeing has met or exceeded all contractual requirements. The program continues to track software as a risk, but it does not believe there are any significant software-related issues at this time. The program office also provided technical comments, which were incorporated as appropriate.

LHA 6 America Class Amphibious Assault Ship (LHA 6)

The Navy's LHA 6 class will replace the LHA 1 Tarawa-class amphibious assault ships. The LHA 6 class is based on the fielded LHD 8 and consists of three ships. The ships feature enhanced aviation capabilities and are designed to support Marine Corps assets in an expeditionary strike group. LHA 6 construction began in December 2008 and the ship was delivered in April 2014. LHA 7 construction began in July 2013, and delivery is expected in December 2018. The Navy intends to competitively award a contract for LHA 8 in fiscal year 2016.

Source: Navy photo by Mass Communication Specialist 1st Class Michael McNabb.



Program Essentials

Prime contractor: Huntington Ingalls Industries
Program office: Washington, DC
Funding needed to complete:
R&D: $29.3 million
Procurement: $3,485.9 million
Total funding: $3,516.2 million
Procurement quantity: 1

Program Performance (fiscal year 2015 dollars in millions)

	As of 01/2006	Latest 08/2014	Percent change
Research and development cost	$234.0	$424.1	81.2
Procurement cost	$3,134.1	$9,668.0	208.5
Total program cost	$3,368.1	$10,094.2	199.7
Program unit cost	$3,368.138	$3,364.743	-0.1
Total quantities	1	3	200.0
Acquisition cycle time (months)	146	182	24.7

LHA 6 began construction in December 2008 with mature technologies, but an incomplete design. The ship delivered in April 2014, after a 20 month delay, and has begun post-delivery activities. This includes a May 2015 planned maintenance period where an estimated $42 million will be spent modifying the flight deck to accommodate the Joint Strike Fighter. LHA 7, which largely shares the LHA 6 design, began construction in July 2013. In October 2014, the Navy modified the ship's construction contract to incorporate changes to the flight deck at a cost of up to $40 million, but the program is unsure if these changes will affect the December 2018 planned delivery date. Changes to LHA 8 are more significant and include the addition of a well deck. The program is working with two shipyards and intends to competitively award a contract to one of the yards in fiscal year 2016.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• *Complete three-dimensional product model*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

LHA 6 Program

Technology, Design, and Production Maturity

All LHA critical technologies were mature when the program awarded its first construction contract in June 2007. Although not considered critical technologies, the program identified six additional subsystems necessary to achieve capabilities, which were also considered mature. One subsystem, the Joint Precision Approach and Landing System, was restructured to focus on aircraft auto-land capabilities and is it is uncertain when the system will be ready for installation. In the interim, the LHA class will use backup aviation control systems to meet requirements. Program officials do not anticipate any new critical technologies for LHA 8.

The Navy took delivery of the lead ship (LHA 6) in April 2014, 20 months later than the contracted delivery date. LHA 6 began construction in December 2008 with only 65 percent of its design completed, as measured by a combination of two- and three-dimensional design products. Subsequent design quality issues resulted in more design changes than anticipated, along with higher levels of rework. The ship is now conducting crew familiarization and tests of the combat and mission systems. Post shakedown availability, a planned maintenance period, is currently scheduled to begin in May 2015. During this period, the Navy plans to spend an estimated $42 million to modify the ship's flight deck to cope with exhaust and downwash from the Joint Strike Fighter.

Construction of LHA 7—which largely shares the LHA 6 design—began in July 2013. In October 2014, the Navy modified the ship's construction contract to incorporate changes to the flight deck to accommodate the Joint Strike Fighter, which may cost up to $40 million. Other design changes to LHA 7 include a new firefighting system and updates to the radar and the command, control, communications, computers, and intelligence systems. Program officials are unsure if these changes will cause a delay to LHA 7's expected delivery date of December 2018 as the shipbuilder continues to incorporate the additional work into the ship's construction schedule. Design changes to LHA 8 will be more significant, as the Navy is incorporating a well deck that accommodates two landing craft, and work is underway on design modifications to reduce the ship's acquisition and lifecycle costs. The Navy is working with the two shipyards that it determined were capable of building the ship without major recapitalization to assist with this effort, and intends to competitively award an advanced procurement and detail design contract to a single shipyard in fiscal year 2016.

Other Program Issues

As a result of the high level of rework during construction of LHA 6 that led to cost growth and schedule delays, the shipbuilder is pursuing over 120 lessons learned and affordability initiatives for work on LHA 7. The Navy has also included contract incentives to improve the shipbuilder's performance on LHA 7. However, workforce issues with the yard have contributed to poor cost performance especially in fabricating the ship's hull. In response, the shipbuilder has revised the way it tasks, supervises, and accomplishes work in an effort to improve quality and hold its employees accountable. Program officials note that although it is too early to determine the effectiveness of the shipbuilder's actions, the revised strategy appears to be improving cost performance on LHA 7.

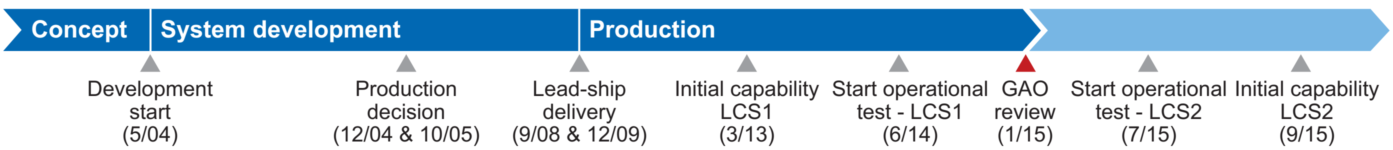
Program Office Comments

In commenting on a draft of this assessment, the program office stated that the delivery date for LHA 7 was extended to December 2018 as a result of negotiations incorporating the Joint Strike Fighter (F-35B) environmental effect design solutions into the contract. They also stated that the shipyard has made significant performance improvement in the hull shop in recent months, and further stated that if the shipbuilder's production progress on LHA 7 continues at the current pace, an early delivery may be achievable. Regarding LHA 8, the program office stated a draft request for proposals was issued in January 2015 as part of a competitive acquisition approach involving the detail design and construction of LHA 8 and T-AO(X) Fleet Oiler Replacement (ships 1 through 6) and the contract design support for LX(R). The program office plans to issue an amendment in September 2015 to incorporate updates to the LHA 8 technical data package as a result of early industry involvement affordability efforts.

Littoral Combat Ship (LCS)

The Navy's LCS is designed to perform mine countermeasures, antisubmarine warfare, and surface warfare missions. It consists of the ship itself, or seaframe, and the mission package it deploys. The Navy bought the first four seaframes in two designs—the Freedom variant, a steel monohull (LCS 1 and odd numbered ships) and the Independence variant, an aluminum trimaran hull (LCS 2 and even numbered ships)—and subsequently awarded a contract for a block buy of up to 10 ships to both contractors. We assessed both seaframe designs.

Source: Lockheed Martin (left); General Dynamics (right).



Program Essentials

Prime contractor: Austal USA, Lockheed Martin
Program office: Washington Navy Yard, DC
Funding needed to complete:
R&D: $340.3 million
Procurement: $8,715.4 million
Total funding: $9,182.4 million
Procurement quantity: 12

Program Performance (fiscal year 2015 dollars in millions)

	As of 05/2004	Latest 09/2014	Percent change
Research and development cost	$939.5	$3,357.5	257.4
Procurement cost	$499.5	$17,773.3	3,458.2
Total program cost	$1,439.0	$21,334.6	1,382.6
Program unit cost	$359.750	$666.707	85.3
Total quantities	4	32	700.0
Acquisition cycle time (months)	41	106	158.5

Cost data are for the seaframe only. Research and development funding includes detail design and construction of two ships.

The LCS seaframe program has demonstrated the maturity of 16 of its 18 critical technologies. The program continues to make design changes based on lessons learned from the delivered ships. The next contract award is currently planned for fiscal year 2016, when 24 of the seaframes will already be delivered, under construction, or under contract. Several test events—including total ship survivability trials on one variant—have taken place in the past year, but not all of the test reports have been completed. The Navy delayed initial operational capability for the Independence variant, LCS 2, from January 2014 until September 2015. The Secretary of Defense directed the Navy to assess options evaluating capability and cost for a future small surface combatant. Based on the results of the study, additional changes will be required for the program.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• Complete three-dimensional product model	●
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

LCS Program

Technology Maturity

Sixteen of the 18 critical technologies for both LCS designs are mature and have been demonstrated in a realistic environment. However, the Navy indicated that the remaining two are also mature because the overhead launch and retrieval system was demonstrated through last year's deployment of LCS 1, and LCS 2's aluminum structure was demonstrated based on its performance in trials and maritime exercises. Yet the Navy stated that the maturity of these technologies has not been formally validated—and no date has been set to do so. Unknowns also remain regarding LCS 2's hull structure, and test events are scheduled through 2016.

Design and Production Maturity

To date, the Navy has accepted delivery of four seaframes; LCS 5 through LCS 16 are in various stages of construction and LCS 17 through 24 are under contract. The next contract award is planned for 2016. The Navy continues to incorporate changes into follow-on ship designs, including an updated radar starting on LCS 17, and Freedom class gunfire control system improvements. LCS 1 and 2 do not meet certain performance requirements and face capability limitations due to weight growth during construction. As a result, these ships lack the required amount of service life allowance—the margin to accommodate future changes—without removing weight over the ship's lifetime.

The Navy declared initial operational capability for the Freedom variant when LCS 1 deployed to Singapore in March 2013. DOD's test authority reported in December 2013 on the results of this early fielding with the surface warfare mission package. It noted a number of issues with the seaframe and its planned capabilities, including survivability. The Freedom variant began formal operational testing in fiscal year 2014 and completed total ship survivability trials in October 2014, but the results are not yet available.

DOD and Navy test officials have not yet assessed the survivability or cyber defense capabilities of the Independence variant. The Navy continues to develop and test the LCS 2 combat system, and the software and system integration necessary to achieve baseline capabilities will not be complete until September 2015. LCS 2 completed rough water trials in January 2014, the results of which are pending completion of a final test report. The Navy discovered cracks in the mission bay following this testing and imposed a weight limit on the LCS 2 and LCS 4 launch and recovery systems. In lieu of completing final contract trials on the Independence variant, the Navy's Board of Inspection and Survey conducted a one-day special trial in August 2014, and the Navy does not plan to to complete the acceptance trial for LCS 2. According to the Navy, the initial operational capability of LCS 2 has been delayed until September 2015 as a result of funding restrictions for one type of mission package.

Other Program Issues

In February 2014, the Secretary of Defense directed the Navy to contract for no more than 32 ships, citing concerns about the ships' survivability and lethality. The Secretary also directed the Navy to create a task force to evaluate a range of cost and capability options for a future small surface combatant, including an improved LCS. The Navy recommended a modified LCS to satisfy DOD's small surface combatant requirement and plans to buy 20 additional LCS hulls, which will be reclassified as frigates, starting in fiscal year 2019.

Program Office Comments

In commenting on a draft of this assessment, the program office noted that it continues to test the long-term behavior of the LCS 2's aluminum hull. The program office is modifying LCS 1 and 2 designs to ensure they meet service life allowance requirements. The LCS 2 Combat System is functional and is supporting developmental testing onboard LCS 2. Both variants of LCS achieved operational and developmental testing milestones. In 2015, LCS will achieve Initial Operational Capability for the LCS 2 variant. The intent of the LCS 2 Special Trial was to identify deficiencies, test the ship, and deliver a report card to US Fleet Forces Command. The scope included standard underway demonstrations. The program office indicated that, with over four years of robust developmental testing the performance of the ship, and its systems are well understood. The program office also provided technical comments, which were incorporated where deemed appropriate.

Littoral Combat Ship - Mission Packages (LCS MP)

The Littoral Combat Ship (LCS) will provide mine countermeasures (MCM), surface warfare (SUW), and antisubmarine warfare (ASW) capability using mission packages. Packages include weapons and sensors launched and recovered from LCS seaframes. The Navy plans to deliver capability incrementally and has set interim requirements below the baseline requirements for some of the planned increments. We assessed mission packages' progress against the threshold requirements that define the baseline capabilities currently expected for each package.

Source: U.S. Navy.

Concept | System development/Production

- First MCM delivery (9/07)
- First SUW delivery (7/08)
- First ASW delivery (9/08)
- DOD program review (7/13)
- Initial capability SUW (11/14)
- GAO review (1/15)
- Initial capability MCM (9/15)
- Initial capability ASW (9/16)

Program Essentials

Prime contractor: Northrop Grumman Systems Corporation
Program office: Washington Navy Yard, DC
Funding needed to complete:
R&D: $725.0 million
Procurement: $3,662.1 million
Total funding: $4,418.7 million
Procurement quantity: 47

Program Performance (fiscal year 2015 dollars in millions)

	As of 8/2007	Latest 09/2014	Percent change
Research and development cost	NA	$2,396.1	NA
Procurement cost	$3,452.1	$4,278.9	24.0
Total program cost	$3,982.7	$6,706.6	NA
Program unit cost	$62.230	$104.791	NA
Total quantities	64	64	0.0
Acquisition cycle time (months)	NA	NA	NA

The current estimate does not include $3.6 billion of procurement funding for life cycle replacement and modernization of mission systems.

The Navy has accepted delivery of 11 mission packages since 2004 prior to demonstrating that these packages meet threshold requirements on either seaframe class. The MCM package recently completed developmental tests for the first increment of capability and is continuing to develop sub-systems to meet the full threshold requirement. The current increment of the SUW package met its interim requirements on one seaframe, and the Navy is currently modifying an Army missile to provide capabilities to meet full requirements. The ASW package currently exceeds its weight parameters and the program is seeking ways to reduce that weight. The Navy is still developing, testing, and integrating the sub-systems needed to meet full requirements on both seaframe variants and is not expected to field a set of mission packages that meet full requirements until 2020.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	○
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

LCS Packages Program

Mine Countermeasures (MCM)

The Navy has accepted five MCM packages without demonstrating that they meet interim—or threshold—requirements and plans to accept one more in fiscal 2015. The package will field in four increments: the first is designed to remove sailors from the minefield and improve mine detection, classification, and neutralization over legacy vessels. Operational testing for the first increment is scheduled to begin in fiscal 2015 on both variants. Future increments, needed to meet threshold requirements, are intended to provide additional capability to detect mines as well as different means of neutralizing them.

Surface Warfare (SUW)

The Navy has accepted five SUW packages and plans to accept two more in fiscal year 2015. Each package currently consists of two 30 millimeter guns, an armed helicopter, and two rigid hull inflatable boats. In August 2014, the Navy found that the current package met its interim performance requirements on the Freedom variant (LCS 1) and declared initial operational capability in November 2014. Operational testing of the current package with the Independence variant (LCS 2) is planned for 2015. To meet threshold requirements for SUW the Navy needs a surface-to-surface missile and plans to use the Army's Longbow Hellfire missile for this capability, as it canceled previous efforts with the Griffin missile. According to program officials, initial demonstrations with Longbow Hellfire have been successful, and the Navy is currently integrating this missile with both variants of the LCS. Operational testing is planned for fiscal 2016, with initial capability planned for fiscal 2017.

Antisubmarine Warfare (ASW)

According to the Navy, the systems that comprise the ASW mission package are mature as they have been fielded by United States and foreign navies. In September 2014, the Navy completed development testing aboard the Freedom variant. Program officials report that currently the mission package is 5 tons too heavy to fit within the parameters reserved for the packages. According to program officials, the Navy is soliciting industry for suggestions to reduce the package's weight by at least 15 percent. The Navy is planning to meet the threshold requirement for ASW in 2016.

Other Program Issues

The Navy continues to procure LCS seaframes, even though the sub-systems necessary to meet full mission package requirements have not yet been fully developed, demonstrated, and integrated with either seaframe class. Integrating these systems on the LCS seaframe is challenging because of limitations on space and weight inherent in the seaframe designs. The Navy will not achieve the capability to meet full requirements for all three of the mission packages until 2020, by which time it plans to take delivery of 24 ships.

Program Office Comments

The Navy states that it is purchasing the quantity of mission systems and packages needed for system integration, crew training, developmental testing, operational testing, and LCS operational deployments. The mission packages have all been demonstrated in a relevant environment prior to mission package integration, and therefore, the LCS program is purchasing the mission systems in accordance with DOD guidance and regulations. Further, the Navy is following its plan to incrementally deliver operationally effective mission package capability to the fleet rather than waiting years to acquire all mission systems needed to meet the threshold requirements. For example, initial SUW capability has been fielded and initial MCM capability will be fielded in fiscal 2015.

GAO Response

The systems that comprise the Navy's mission packages have yet to work successfully together to achieve results. For example, none of the mission packages for any increment have achieved interim requirements on the Independence variant, or meet its threshold requirements for either seaframe. In the absence of a defined increment-based approach to sequentially gain knowledge and meet requirements, the Navy's acquisition approach is not in accordance with best practices.

M109A7 Family of Vehicles

The Army's M109A7 Family of Vehicles (M109A7 FOV) system consists of two individual platforms, a self-propelled howitzer (SPH) and a tracked ammunition carrier that provides operational support. The SPH is a tracked, aluminum armored vehicle with a 155 millimeter cannon. The M109A7 FOV is expected to provide improved sustainability over the current howitzer fleet through the incorporation of a newly designed hull; modified M2 Bradley infantry fighting vehicle power train, suspension system, and track; and a modernized electrical system.

Source: U.S. Army.

Program Essentials

Prime contractor: BAE Systems Land & Armament L.P.
Program office: Warren, MI
Funding needed to complete:
- R&D: $269.2 million
- Procurement: $5,580.8 million
- Total funding: $5,850.0 million
- Procurement quantity: 539

Program Performance (fiscal year 2015 dollars in millions)

	As of 02/2012	Latest 08/2014	Percent change
Research and development cost	$1,067.5	$1,118.8	4.8
Procurement cost	$6,015.5	$5,964.4	-0.8
Total program cost	$7,083.0	$7,083.2	0.0
Program unit cost	$12.170	$12.694	4.3
Total quantities	582	558	-4.1
Acquisition cycle time (months)	118	118	0.0

The M109A7 FOV program entered low-rate production in October 2013 with its two critical technologies mature and design stable. However, the program faces a number of design challenges related to the fire control system, cannon barrel, and cross-drive steering transmission that could result in cost increases and program delays. As of August 2014, the program office indicated that a number of manufacturing processes and systems are not fully mature and the capability to produce the vehicles will be not be demonstrated until after production begins. Additionally, the current schedule has a limited amount of time and flexibility to correct any potential deficiencies identified during developmental testing. As a result, the Army may accept some low-rate production vehicles that have not completed developmental testing and could need costly retrofits.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• Demonstrate critical processes are in control	○
• Demonstrate critical processes on a pilot production line	○
• Test a production-representative prototype	●

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

M109A7 FOV Program

Technology Maturity
The M109A7 FOV program's two critical technologies—power pack integration and the ceramic bearing of the generator assembly—have been assessed as fully mature. These technologies are identified as critical based on concerns about their performance at high temperatures. While neither technology is new or novel, failure of either would represent a major program risk.

Design Maturity
According to the program office, the design is currently stable with all of the expected drawings released and it has been demonstrated using a system-level prototype; however, the program faces a number of design challenges. A key component in the M109A7's fire control system may need to be redesigned because early test results indicate that it does not meet current operating specifications. Program officials stated that the design life of the cannon barrel cannot be achieved, but a repair process has been developed for the current fleet until new production assets are obtained. One option to extend the life of the cannon barrel is to use a new chrome-plated barrel. The program plans to test fire the chrome-plated cannon barrel and the results will determine whether or not the design change will be approved. If approved, the new production cannon barrels would be chromed and transferred to the M109A7s during vehicle production. This expense would be absorbed by the M109A6 program. Additionally, program officials are considering a new cross-drive transmission that could potentially cost the program an additional $150 to $200 million. According to program officials, this effort is under consideration to maintain commonality with the Bradley and Armored Multi-Purpose Vehicle platforms in the future.

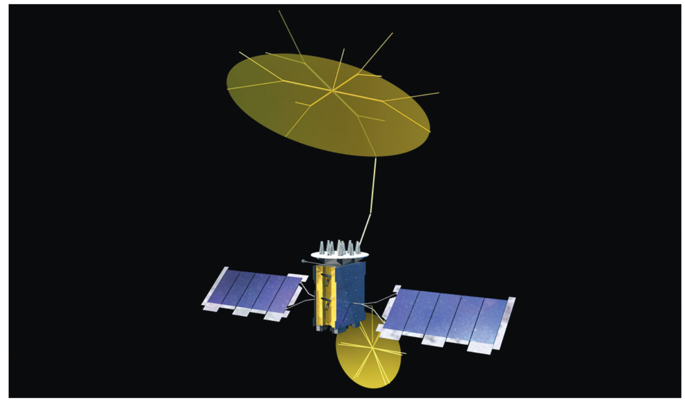
Production Maturity
The program was approved for low-rate production in October 2013, with the first vehicle scheduled to be delivered in March 2015. To assess its production readiness, the program is using metrics related to labor, defects, and manufacturing readiness levels. However, the program's manufacturing readiness levels for process capability and control indicate that its production processes and capability are not in statistical control and will not be demonstrated until after production begins. Our best practices work has shown that if a program's manufacturing processes and capability are not demonstrated and in control using a production-representative prototype before production begins, it is at risk of not meeting cost and schedule targets.

Other Program Issues
The program's current plans are schedule driven with a limited amount of time to correct deficiencies identified during developmental testing. For example, the program intends to demonstrate previously identified design changes in prototype vehicles prior to starting low-rate-production to reduce risk. However, if sufficient time is not allotted to successfully complete these tests and make any necessary corrections, the Army may accept low-rate production vehicles that require potentially costly retrofits. Additionally, the program is facing another possible design change based on its inability to meet specific information assurance requirements which will also need to be completed and tested prior to production. Each of these design changes, if not completed and tested prior to production, could adversely impact the program's cost and schedule.

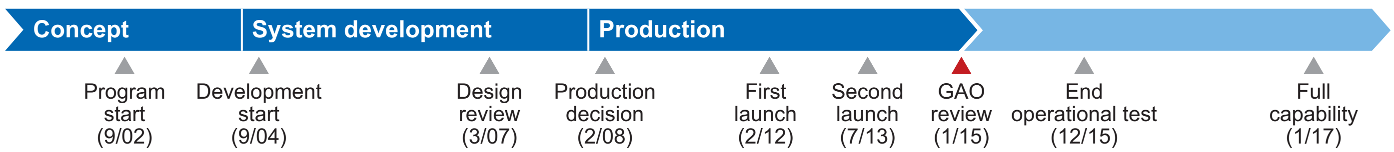
Program Office Comments
In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated as appropriate.

Mobile User Objective System (MUOS)

The Navy's MUOS, a satellite communication system, is expected to provide a worldwide, multiservice population of mobile and fixed-site terminal users with increased narrowband communications capacity and improved availability for small terminal users. MUOS will replace the Ultra High Frequency (UHF) Follow-On (UFO) satellite system currently in operation and provide interoperability with legacy terminals. MUOS consists of a network of satellites and an integrated ground network. We assessed both the space and ground segments.



Source: © 2007 Lockheed Martin.



Program Essentials

Prime contractor: Lockheed Martin Space Systems
Program office: San Diego, CA
Funding needed to complete:
- R&D: $268.0 million
- Procurement: $963.5 million
- Total funding: $1,231.5 million
- Procurement quantity: 1

Program Performance (fiscal year 2015 dollars in millions)

	As of 12/2004	Latest 08/2014	Percent change
Research and development cost	$3,863.5	$4,654.1	20.5
Procurement cost	$3,214.6	$2,882.4	-10.3
Total program cost	$7,119.1	$7,606.0	6.8
Program unit cost	$1,186.518	$1,267.659	6.8
Total quantities	6	6	0.0
Acquisition cycle time (months)	90	NA	NA

Latest acquisition cycle time could not be calculated because the most recent MUOS program baseline does not provide dates for initial operational capability.

The MUOS program's critical technologies are mature, its design is stable, and according to the program office, the manufacturing metrics it monitors remain stable. The first satellite was launched in February 2012—26 months later than planned at development start—and the second was launched in July 2013. Shipment of a third satellite was delayed about four months due to problems with the UHF legacy payload and was launched in January 2015. The first two satellites currently provide legacy satellite communications to the warfighter, though more advanced communications using the MUOS waveform are not yet operational. According to the program, development of the waveform was completed in December 2012 and continues to be updated. However, challenges with integrating the waveform with terminals and ground systems persist.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

MUOS Program

Technology, Design, and Production Maturity

The MUOS program's technologies are mature and its design is stable. The first two satellites are on orbit and currently provide operational support to the warfighter in the form of legacy UHF satellite communications. A third satellite was launched in January 2015 and will begin on-orbit testing before it is accepted for operational use. Two other satellites are being built, with a sixth planned for procurement in 2022. We could not assess whether critical manufacturing processes were in control as the program does not collect statistical process control data. However, program officials indicated that there has been no significant change in metrics used to assess production maturity, such as number of defects per 1,000 hours of labor, amount of deferred work and associated risk, and rate of resolving nonconformance issues. Also, the number of manufacturing defects on the space segment has decreased over time, according to the program.

Other Program Issues

Due to problems with uncommanded shutdowns of the UHF legacy payload during testing, delivery of the third production satellite is delayed until June 2015. The fourth production satellite will now constitute the third satellite for launch, which was ready to ship to the launch site in October 2014. Though the delay constitutes a 4-month schedule breach, the program reported there are no cost or performance implications because the satellite is procured under a fixed-price incentive contract and the UHF payloads on orbit are providing sufficient capability. The program office does not expect subsequent satellites to be affected by the same issues, and expects deliveries will meet scheduled dates.

Since 2007, we have reported that synchronizing delivery of MUOS satellites with compatible Joint Tactical Radio System (JTRS) Handheld, Manpack, and Small Form Fit (HMS) terminals—developed by the Army as the first operational terminals to incorporate the MUOS waveform—has been a challenge. Launching MUOS satellites is important to sustain legacy UHF communications, but use of over 90 percent of MUOS' planned capability is dependent on resolving issues related to integrating the MUOS waveform, HMS terminals, and ground systems. The MUOS program completed waveform lab testing using a generic hardware platform in December 2012. According to program officials, MUOS successfully demonstrated initial porting and integration of the waveform with HMS in 2013 and has since upgraded waveform software to improve performance. However, operational testing of the waveform, HMS terminal, and ground system—initially planned for June 2014—has been delayed due to reliability issues. The program extended testing to fix software issues and continues to work with the Army's HMS program. The program office stated that operational testing is on track to be completed by December 2015—an 18-month delay—though this will also delay the Army's fielding of MUOS-capable radios.

The risk of similar integration issues occurring with future terminals will be reduced, according to program officials, with the recent opening of MUOS labs to all terminal developers for testing and once Military Standard requirements are published and accessible to industry. The MUOS waveform has been available for integration on other terminal platforms since January 2013, with the latest version released in July 2014.

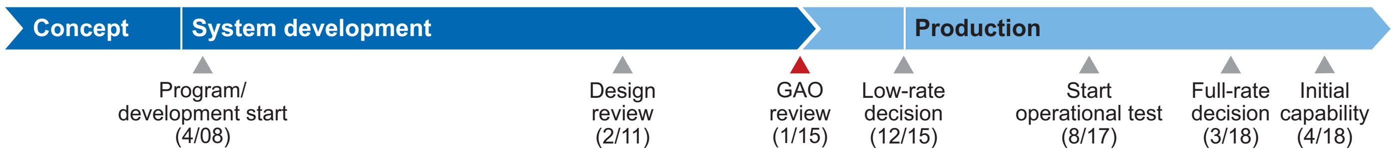
Program Office Comments

In commenting on a draft of this assessment, the Navy provided technical comments which were incorporated as appropriate.

MQ-4C Triton Unmanned Aircraft System (MQ-4C Triton)

The Navy's MQ-4C Triton is intended to provide persistent maritime intelligence, surveillance, and reconnaissance (ISR) capability. Triton will operate from five land-based sites worldwide as a part of a family of maritime patrol and reconnaissance systems. Based on the Air Force RQ-4B Global Hawk air vehicle, the Triton is a critical part of the Navy's plan to recapitalize its airborne intelligence, surveillance, and reconnaissance assets by the end of the decade.

Source: Courtesy Northrop Grumman/Robert Brown.



Program Essentials

Prime contractor: Northrop Grumman Systems Corporation
Program office: Patuxent River, MD
Funding needed to complete:
R&D: $625.1 million
Procurement: $9,404.8 million
Total funding: $10,176.9 million
Procurement quantity: 66

Program Performance (fiscal year 2015 dollars in millions)

	As of 02/2009	Latest 07/2014	Percent change
Research and development cost	$3,327.4	$3,992.4	20.0
Procurement cost	$9,874.4	$8,448.2	-14.4
Total program cost	$13,607.0	$12,766.5	-6.2
Program unit cost	$194.385	$182.378	-6.2
Total quantities	70	70	0.0
Acquisition cycle time (months)	92	120	30.4

The Triton program's single, identified critical technology is mature. While the design is stable, recent growth in drawings indicates that the program overestimated design stability at the 2011 critical design review. After delays related to software and hardware challenges, the Triton completed initial flight testing and flew its first test aircraft across the country to Maryland, where the Navy will integrate and test the mission systems in preparation for the Triton's low-rate production decision in December 2015. Triton faces design and production risks as a result of an ambitious schedule to meet the estimated date for the start of production and supplier quality management challenges. In addition, the program's schedule for development testing extends significantly into production, increasing the risk of cost and schedule growth late in the program.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

MQ-4C Triton Program

Technology and Design Maturity

The program's single critical technology—a hydrocarbon sensor—is mature. At the program's critical design review in 2011, the design was considered stable as the Navy reported that more than 90 percent of its total estimated design drawings were releasable. Since then, the total number of design drawings has increased significantly. When adjusted for this increase, the program would have only had 56 percent of its drawings released at the critical design review. Program officials noted that the drawings releasable at that time included those for the air vehicle only, and did not include other components, including the ground station, which accounted for the largest increase in drawings.

Production Maturity

The Navy faces supplier quality management challenges that could impact its readiness to begin Triton production in December 2015. DOD has issued at least eight corrective action requests that require the prime contractor to conduct a root cause analysis or take other actions. Most of the requests are related to supplier material and quality management issues. The wing represents one of the program's most significant challenges. DOD reported that the wing supplier has not yet demonstrated that it can produce a wing that conforms to required specifications. Quality issues have already delayed delivery of the wings for two of the developmental test aircraft by at least five months. The Navy is still working to identify and mitigate key manufacturing risks for each major supplier and plans to conduct the executive production readiness review in May 2015, at which time it will reassess Triton manufacturing processes and develop a plan to ensure that those processes are sufficiently mature before the low-rate initial production decision in December 2015.

Other Program Issues

The program anticipates conducting significant amounts of testing concurrent with production. Triton flight testing was delayed due to problems with the performance of the aircraft's flight management computer and the aircraft's wing and tail. Following the resolution of these issues, all three developmental test aircraft were flown across the country to Naval Air Station Patuxent River by December 2014, where the Navy expects to integrate and test the aircraft's mission systems. The program faces an ambitious schedule in which the Navy expects to complete approximately 13,000 of 25,000 total developmental test points before seeking approval to begin production in December 2015. The remaining 12,000 test points will be completed during production. In addition, the Navy has delayed the start of fatigue testing on the aircraft until 2017, two years after the start of production. According to program officials, this testing has been delayed twice as costs have increased and funding has been diverted to other development activities. Based on the current production schedule, the Navy will have ordered at least 34 aircraft, and delivered at least 22, before the full results of this testing are available in 2023. Without knowledge about the long-term durability of the aircraft, the Navy may have to initially limit its missions or its life-span. Our previous work suggests that such concurrency in testing and production can increase the risk of discovering deficiencies in production that could require costly design changes and modifications to systems already produced.

Program Office Comments

In addition to providing technical comments, the program office noted that the MQ-4C Triton UAS program continues to demonstrate success during its system development and demonstration phase as evidenced by completion of initial envelope expansion in March 2014 and the ferry of all three test aircraft to Patuxent River in late calendar year 2014. While the program has experienced delays to wing delivery for the two system demonstration test articles, production planning is on schedule for aircraft delivery in support of Initial Operational Test & Evaluation. The program is on track to conduct its operational assessment in summer 2015 and is conducting supplier production readiness reviews in preparation for the Milestone C/Low-Rate Initial Production decision review in the first quarter of fiscal year 2016. The Triton Unmanned Aircraft System program benefits from strong support within the Department of the Navy.

MQ-8 (Fire Scout)

The Navy's MQ-8 unmanned aerial vehicle is intended to provide real-time imagery and data in support of intelligence, surveillance, and reconnaissance missions. The MQ-8 system is comprised of one or more air vehicles with sensors, a control station, and ship equipment to aid in launch and recovery. The air vehicle launches and lands vertically, and operates from ships and land. The MQ-8 is intended for use in various operations, including surface, anti-submarine, and mine warfare. We assessed the latest variant, the MQ-8C.

Source: Northrop Grumman Systems Corporation.

Concept | **System development** | **Production**

- Program start (1/00)
- Design review (11/05)
- MQ-8C first flight (10/13)
- GAO review (1/15)
- Start operational test (7/15)
- Production decision (3/16)

Program Essentials

Prime contractor: Northrop Grumman
Program office: Patuxent River, MD
Funding needed to complete:
- R&D: $174.6 million
- Procurement: $1,726.2 million
- Total funding: $1,900.9 million
- Procurement quantity: 96

Program Performance (fiscal year 2015 dollars in millions)

	As of 12/2006	Latest 07/2014	Percent change
Research and development cost	$633.4	$896.3	41.5
Procurement cost	$1,782.0	$2,164.3	21.5
Total program cost	$2,770.0	$3,060.6	10.5
Program unit cost	$15.650	$24.290	55.2
Total quantities	177	126	-28.8
Acquisition cycle time (months)	104	170	63.5

The MQ-8 program reported a Nunn-McCurdy unit cost breach of the critical threshold, resulting in a program restructuring that will incorporate the planned upgrades to the range, endurance, and payload for the MQ-8C. According to program officials, these upgrades rely on mature technologies and designs derived from earlier efforts. MQ-8C will continue with developmental testing and will transition to operational testing in the fourth quarter of fiscal year 2015. Program officials told us that the program will re-enter the acquisition process at production, which is scheduled for March 2016, and may go directly to full-rate production, depending on the success of testing. We could not assess the planned maturity of the program's production processes as they do not utilize our best practice metrics.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• Demonstrate critical processes are in control	....
• Demonstrate critical processes on a pilot production line	●
• Test a production-representative prototype	●

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

Fire Scout Program

Technology and Design Maturity

According to the program office, MQ-8C has 90 percent commonality with the previously developed MQ-8B, with the primary difference being structural modifications to accommodate the MQ-8C's larger airframe and fuel system. The MQ-8C relies on mature technologies common to the MQ-8B and has completed all of its planned engineering design drawings as of August 2014. First flight for the MQ-8C occurred in October 2013. The program will continue with developmental testing and transition to operational testing in the fourth quarter of fiscal year 2015. Despite the separate iteration of development, the MQ-8C did not have a separate system development decision which, according to program officials was not required.

Production Maturity

The program has already procured some MQ-8C aircraft under the Navy's rapid deployment capability procurement process, which enabled the program to bypass many standard acquisition practices. Program officials stated that, as result of the restructuring, the MQ-8C variant will enter the acquisition process at production, which is currently scheduled for March 2016. However, the program may bypass the low-rate decision and proceed straight into full-rate production depending on the success of developmental and operational testing.

We could not assess whether critical manufacturing processes were in control as the program does not collect data on statistical process controls or assess process capabilities using manufacturing readiness levels. The program office collects metrics on the status of production from the prime contractor, such as discovery of manufacturing defects and adherence to delivery schedules. Program officials noted that the MQ-8C air vehicle is a commercial airframe procured by the government and provided directly to the prime contractor as government furnished equipment for conversion to a MQ-8C. The prime contractor is responsible for integration of the avionics and working with the aircraft manufacturer to modify the commercial airframe with increased capacity fuel tanks, new electrical systems, and provisions for the unmanned avionics.

Other Program Issues

The program reported a Nunn-McCurdy unit cost breach of the critical threshold in April 2014. The breach was triggered after the program included the capabilities of the MQ-8C into the program of record and reduced quantities, leading to an average unit cost increase of 71 percent over the original baseline. In June 2014, the program was certified as essential to national security and allowed to proceed. The restructured program will incorporate the upgraded MQ-8C, as well as radar and weapons capabilities, such as those developed by the Navy.

Program Office Comments

In commenting on a draft of this assessment, the program office stated the restructured MQ-8 program realizes the Navy's investments in both the MQ-8B and MQ-8C variants and improves alignment with the Navy's small surface combatant fleet requirements. Recent test events provide high confidence in the maturity of the system and have contributed greatly to reducing the risk to successful completion of planned operational testing and fleet introduction. The program office and the Navy also provided technical comments, which were incorporated where appropriate.

Next Generation Operational Control System (GPS OCX)

The Air Force's Global Positioning System Next Generation Operational Control System (GPS OCX) is to replace the current ground control system for legacy and new GPS III satellites. GPS OCX is expected to ensure reliable and secure delivery of position and timing information to military and civilian users. The Air Force plans to develop GPS OCX in blocks, with each block delivering upgrades as they become available. We assessed the initial three blocks, which support the launch, checkout, and operation of GPS II and III satellites .

Source: U.S. Air Force.

Concept | **System development** | **Production**

- Program start (2/07)
- Development start (11/12)
- GAO review (1/15)
- Initial capability - Block 0 (11/15)
- Start operational test (12/18)
- Low-rate decision (7/18)
- Initial capability - Block 1 (11/18)
- Initial capability - Block 2 (11/19)

Program Essentials

Prime contractor: Raytheon
Program office: El Segundo, CA
Funding needed to complete:
R&D: $988.0 million
Procurement: $0.0 million
Total funding: $988.0 million
Procurement quantity: 0

Program Performance (fiscal year 2015 dollars in millions)

	As of 11/2012	Latest 09/2014	Percent change
Research and development cost	$3,507.1	$3,501.5	-0.2
Procurement cost	$0.0	$0.0	0.0
Total program cost	$3,507.1	$3,501.5	-0.2
Program unit cost	$3,507.125	$3,501.467	-0.2
Total quantities	1	1	0.0
Acquisition cycle time (months)	55	84	52.7

GPS OCX formally entered system development in November 2012, more than two years after awarding the development contract. The program's 14 critical technologies are still nearing full maturity. The program consists of three blocks: Block 0 is intended to support the launch and checkout of GPS III satellites; Block 1 is designed to command and control GPS II and III satellites and basic modernized military signals; and Block 2 is to enable the full modernized military signal and supports, monitors, and controls additional navigation signals. Block 1 and 2 capabilities are expected to be delivered more than two years later than planned. Aligning the schedules for GPS OCX and GPS III is a risk for both programs. Block 1 is scheduled to become operational by November 2018, more than two years after the date of the first GPS III satellite's availability for launch.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

GPS OCX Program

Technology Maturity

GPS OCX entered system development in November 2012 with all of its 14 critical technologies nearing full maturity. However, the program awarded the development contract over two years before formally entering system development. According to program officials, at this time requirements for key capabilities—including the information assurance—were poorly defined and had not completed systems engineering reviews. According to the Air Force and the contractor, since requirements were not fully defined, developing the information assurance capability has been more difficult than planned, and is more complex than initially realized. Program office documents show that new, flexible, and complex protections beyond those developed previously are required to meet OCX's needs. The contractor originally planned to use commercial off-the-shelf and open source software to develop this capability, but found many unexpected deficiencies in both sets of software code that required significant amounts of rework. To mitigate these issues, the contractor put together teams of personnel to fix, patch, and scan deficiencies while the government added an in-plant team to better plan deficiency resolution actions.

Design and Production Maturity

In 2014, the program office changed its approach to developing and testing each software block. Previously, software was developed and tested incrementally with a critical design review after each stage to ensure design stability. According to program officials, in an effort to mitigate the instability in requirements caused by incomplete systems engineering that was causing large amounts of rework, the program suspended all software development activities for Block 1 and 2 until systems engineering is completed for Block 1. This is currently expected in February 2015. Program officials said software development for Block 0 is complete and remaining testing for this block is scheduled for completion in November 2015.

Other Program Issues

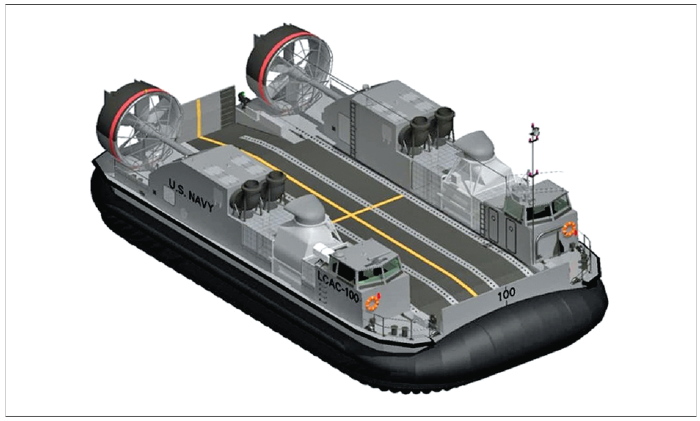
The program experienced a schedule delay of more than 2 years and—due to rework—the cost of the contract has approximately doubled after completing an over target baseline with the contractor in July 2014. The program anticipates breeching the cost baseline established at Milestone B and expects to have a revised baseline in the second quarter of fiscal year 2015. GPS OCX's development delays, combined with the program's late start relative to GPS III, have resulted in considerable risk in aligning the schedules of GPS OCX and GPS III satellites. Block 1 is now scheduled to be operational in November 2018. Air Force officials said they do not plan to launch a second GPS III satellite until GPS OCX has demonstrated its capabilities as the GPS III satellite will have very limited capabilities until GPS OCX is operational.

Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated as appropriate.

Ship to Shore Connector Amphibious Craft (SSC)

The Navy's SSC is an air-cushioned landing craft intended to transport personnel, weapon systems, equipment, and cargo from amphibious vessels to shore. SSC is the replacement for the Landing Craft, Air Cushion, which is approaching the end of its service life. The SSC is designed to deploy in Navy well deck amphibious ships, such as the LPD 17 class, and for use in assault and nonassault operations. The program entered system development in July 2012 and held its production readiness review in September 2014.



Source: U.S. Navy.

Concept | **System development** | **Production**

Program start	Development start	Design review	GAO review	Low-rate decision	Complete operational test	Full-rate decision	Initial capability
(5/09)	(7/12)	(9/14)	(1/15)	(2/15)	(8/18)	(12/18)	(8/20)

Program Essentials

Prime contractor: Textron, Inc.
Program office: Washington, DC
Funding needed to complete:
R&D: $87.2 million
Procurement: $3,470.5 million
Total funding: $3,577.1 million
Procurement quantity: 71

Program Performance (fiscal year 2015 dollars in millions)

	As of 07/2012	Latest 08/2014	Percent change
Research and development cost	$589.5	$564.2	-4.3
Procurement cost	$3,577.6	$3,470.5	-3.0
Total program cost	$4,186.9	$4,054.1	-3.2
Program unit cost	$57.354	$55.535	-3.2
Total quantities	73	73	0.0
Acquisition cycle time (months)	135	135	0.0

The program's one critical technology, the fire suppression system, is mature. Two other significant technologies are still recognized by the program as potential risk areas. The SSC's critical design review took place in September 2014—six months later than planned, which SSC officials stated was due primarily to the prime contractor's efforts to transition all subcontractors to fixed-price type contracts. The program reported that only 79 percent of expected engineering design drawings were releaseable at the time of the review. The SSC also held its production readiness review in September 2014 and determined that the program was ready to begin fabrication of the test and training craft, which began in November 2014. With recent schedule changes, the program plans to exercise options for a total of eight craft before the delivery of the test craft, currently projected for May 2017.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at 90 percent of design drawings	○
• Test a system-level integrated prototype	○
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

SSC Program

Technology Maturity

The SSC program's single identified critical technology, the fire suppression system, is mature. Two other technologies—the gas turbine engine and the command, control, communication, computer and navigation (C4N) system—were identified by DOD as watchlist items in 2010 because they could need further development or modifications for integration with SSC. In December 2014, a Navy technology review panel revisited these items and found that no new development was necessary, but recommended steps for further testing. The program recognizes the watchlist items, along with integration of the drive train, as potential risk areas. The prime contractor is establishing endurance testing of the entire drive train—including the engine—which is currently planned for early 2016. According to program officials, software development for the C4N system is meeting expectations. The program currently anticipates that more than half the total lines of software code required will be reused from existing code.

Design Maturity

The SSC's critical design review took place in September 2014—six months later than planned. According to program officials, the delay was due primarily to the prime contractor's efforts to transition all subcontractors to fixed-price type contracts, which proceeded more slowly than anticipated. This also led to delays in transferring design deliverables to the Navy. The program reported that 515 of 651 expected engineering design drawings, or 79 percent, were releasable to the manufacturer at critical design review. According to program officials, two weeks after the critical design review, the amount of releasable drawings increased to 552, or 85 percent of the expected amount. Our prior work in weapons acquisition indicates that successful completion and release to manufacturing of at least 90 percent of design drawings by critical design review is a best practice that demonstrates design stability and readiness to proceed to system demonstration.

Production Maturity

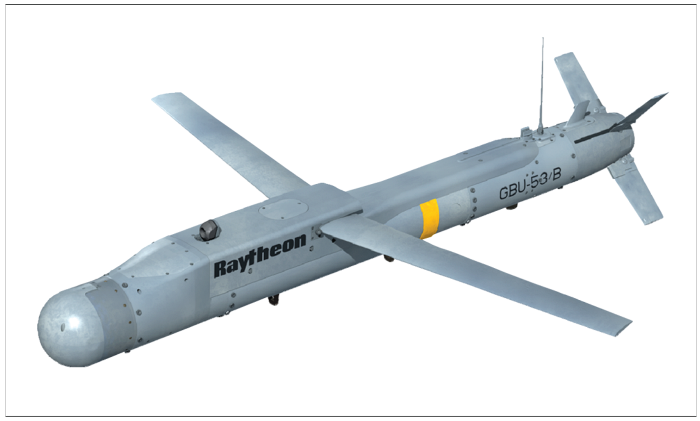
The SSC held its production readiness review in September 2014—only two weeks after its design review—and determined that the program was ready to begin fabrication of the test and training craft, which started in November 2014. Fabrication of the second craft started two months later in January 2015. The delivery of the test and training craft is a critical event as it represents the first opportunity to demonstrate that the SSC's capabilities meet requirements before committing to production. However, the program currently plans to enter low-rate production in February 2015, more than two years before the estimated delivery of the test vehicle. In addition, due to delays in the production decision and test schedules, the program plans to exercise low-rate production options for two additional craft and will now have a total of eight under contract prior to delivery of the test craft, currently projected for May 2017. Our prior work has shown that programs with concurrency in development and production run the risk of cost and schedule overruns if deficiencies in the design are not discovered until late in testing and retrofits are required for previously produced craft.

Program Office Comments

According to the Navy, SSC is a technically mature, low risk program. The Navy-led contract design incorporated lessons learned from 30 years of Navy landing craft, air cushion production, and operational experience. A detail design and construction contract was awarded in July 2012. The program successfully held the design review and production readiness review in September 2014, assessing design maturity and readiness, material and component availability, and the industry team's ability to start and sustain fabrication. At the design review, the command's chief engineer approved the product baseline. Production on the first two crafts began in November 2014 and January 2015, respectively. The program is currently conducting developmental testing, including reliability growth testing, to support the initial production decision. The program office also provided technical comments, which were incorporated where deemed appropriate.

Small Diameter Bomb Increment II (SDB II)

The Air Force's Small Diameter Bomb Increment II (SDB II) is designed to provide attack capability against mobile targets in adverse weather from standoff range. It combines radar, infrared, and semiactive laser sensors in a tri-mode seeker to acquire, track, and engage targets. It uses airborne and ground data links to update target locations, as well as GPS and an inertial navigation system to ensure accuracy. SDB II will be integrated with the F-15E, F-16, F/A-18E/F, F-22A, F-35, B-1B, B-2, B-52, A-10 and MQ-9.



Source: © 2009 Raytheon Company.

Concept	System development			Production			
Program start (5/06)	Development start (7/10)	Design review (1/11)	GAO review (1/15)	Low-rate decision (4/15)	Initial capability F-15E (7/17)	Full-rate decision (6/20)	Initial capability JSF (3/22)

Program Essentials

Prime contractor: Raytheon Missile Systems
Program office: Eglin AFB, FL
Funding needed to complete:
R&D: $521.0 million
Procurement: $2,172.9 million
Total funding: $2,693.9 million
Procurement quantity: 16,856

Program Performance (fiscal year 2015 dollars in millions)

	As of 10/2010	Latest 05/2014	Percent change
Research and development cost	$1,741.9	$1,688.4	-3.1
Procurement cost	$3,237.9	$2,210.1	-31.7
Total program cost	$4,979.9	$3,898.5	-21.7
Program unit cost	$.290	$.227	-21.7
Total quantities	17,163	17,163	0.0
Acquisition cycle time (months)	72	84	16.7

The SDB II program expects all of its critical technologies to reach full maturity by the time it enters low-rate production in April 2015. This represents a delay in the start of production of 15 months from previous estimates. All design drawings have been released and the program has successfully completed nine guided flight tests and one live-fire flight test, but, the program failed the second of two required live fire flight tests in December 2014. In preparing for production, the program successfully completed qualification testing for all 12 subsystems, but a fully assembled bomb failed a corrosive qualification test. Officials are conducting failure review boards to determine the corrective actions needed to remedy test failures and will conduct retests, which could further delay the low-rate production decision.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	●
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

SDB II Program

Technology Maturity

SDB II's four critical technologies—guidance and control, multi-mode seeker, net ready data link, and payload—are scheduled to reach full maturity when the program has its low-rate production decision in April 2015, 58 months after the program entered system development. According to program officials, the identified critical technologies have not directly contributed to any flight test failures.

Design Maturity

All of the design drawings have been released and the program successfully completed four guided flight tests in the summer of 2014 to conclude the nine guided flight tests required for the low-rate production decision. All of the recent successful guided flight tests were hybrid tests, meaning that while they did not include a live warhead they did have a live fuze. Two of the recent guided flight tests required SDB II to distinguish between primary and secondary targets. Program officials stated that SDB II is the first weapon in DODs inventory that can independently distinguish between two targets. All nine of the successful guided flight tests were conducted in the normal attack mode, the most difficult of SDB IIs three attack modes. In October 2014, the program failed the second of its two live-fire flight tests required for the low-rate production decision. SDB II failed the retest of the second live-fire test in December 2014. The program will need to successfully retest the live-fire event before proceeding to low-rate production. Program officials stated that they plan to conduct additional guided and live fire flight tests following the low-rate production decision.

Production Maturity

The program's low-rate production decision is not expected to occur until April 2015, a delay of 15 months from the previous estimate. This is due to a delay in the program's system verification review, a prerequisite for low-rate production, which will evaluate a number of factors including the program's flight and system qualification testing. According to program officials, all 12 of the program's subsystems have passed qualification testing, but testing of a fully assembled bomb, or all-up-round, failed a corrosive atmosphere environmental test in June 2014. Officials stated that this test simulates the bomb's exposure to various environmental conditions for an extended period outside of its protective container. The test failed as the wings were unable to deploy properly after exposure. After conducting a failure review board, officials decided to break the test into two parts, one of which will occur in February 2015 and the other in the fourth quarter of fiscal year 2015. Given the second failure of the second live-fire flight test, and the need to retest both the failed flight test and corrosive atmosphere environmental test, the April 2015 date for the low-rate production decision could be considered optimistic. The existing delays to the system verification review and low-rate production have already caused an acquisition program baseline schedule breach for F-15E required assets available, the Air Force's initial capability, which will delay the Air Force's ability to utilize SDB II.

Program Office Comments

According to the program office, they, along with Raytheon Missiles Systems, have made significant progress in developing the weapon and have completed all dynamic systems qualification. Program officials also noted that there is a path to resolve the corrosive atmosphere testing issues. The program office has considered the additional schedule risk of new discoveries in system qualification or developmental flight testing and is confident in its ability to resolve any unexpected technical issues should they arise. The program office also provided technical comments, which were incorporated as appropriate.

Space Fence Increment 1

The Air Force's Space Fence Increment 1 program is developing a large ground-based radar intended to detect and track objects in low and medium Earth orbit and provide this information to a space surveillance network. Space Fence plans to use high radio frequencies to detect and track more and smaller earth-orbiting objects than previous systems. The Air Force awarded a contract for the development and production of the first radar site in June 2014, and included the second radar site as a contract option.

Source: U.S. Air Force.

Concept | **System development/Production**

- Program start (3/09)
- Development start (5/14)
- Final development/ production contract (6/14)
- GAO review (1/15)
- Design review (3/15)
- Start operational test (10/18)
- Initial capability (1/19)

Program Essentials

Prime contractor: Lockheed Martin MST
Program office: Hanscom AFB, MA
Funding needed to complete:
R&D: $705.0 million
Procurement: $0.0 million
Total funding: $705.0 million
Procurement quantity: 0

Program Performance (fiscal year 2015 dollars in millions)

	As of 06/2014	Latest 08/2014	Percent change
Research and development cost	$1,593.6	$1,594.3	0.0
Procurement cost	$0.0	$0.0	0.0
Total program cost	$1,593.6	$1,594.3	0.0
Program unit cost	$1,593.613	$1,594.325	0.0
Total quantities	1	1	0.0
Acquisition cycle time (months)	124	118	-4.8

The Space Fence program has seven critical technologies, which are expected to demonstrate full maturity during or after the critical design review. The program was approved for development start in May 2014, and awarded the contract for the final system development and production of the first radar site in June 2014. The first Space Fence site is expected to meet the Air Force's requirements for initial operational capability, but full capability will only be achieved once a second site is operational. A new data processing system is being developed by the Air Force in a separate acquisition program from Space Fence to accommodate the projected increase in the volume of data generated.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
.... Information not available
Not applicable

Space Fence Inc 1 Program

Technology Maturity

All seven of the program's critical technologies are currently nearing full maturity and are not expected to demonstrate full maturity until the critical design review, scheduled for March 2015. Most of these technologies are focused on the challenges of transmitting and receiving radar data from an array of the size planned for Space Fence, such as calibrating and managing multiple radar beams and processing the tracking data. Program officials stated that some of the technologies may already be at full maturity, as the technology assessment during the preliminary design review only analyzed whether or not the technology was nearing full maturity, and did not look beyond that to determine if they were fully mature. The program office does not expect any problems to arise with demonstrating full maturity in all technologies before the critical design review.

Design and Production Maturity

The final development contract for Space Fence Increment 1 was awarded in June 2014. The program expected to receive the final number of design drawings for the system from the contractor in December 2014. Space Fence is tracking the production maturity of two manufacturing processes that are critical to the radar's production, but these processes are not yet fully mature.

Other Program Issues

Space Fence was approved for development start in May 2014, after a delay of almost two years due to departmentwide reviews and funding uncertainties. The program's acquisition strategy included funding competitive system prototypes to inform contract award for the final system development contract, and key systems engineering reviews were completed prior to development start.

The Air Force awarded a fixed-price incentive system development contract in June 2014 for the design and construction of the first radar site through initial operational capability. The first Space Fence site is expected to meet the Air Force's requirements for initial operational capability, but full capability will only be achieved once a second site is operational. Development and production of the second radar site, which would be Space Fence Increment 2, is a contract option which can be exercised by the Air Force at a later date. If the option is exercised, the second site is planned to begin operations 36 months after initial operational capability. According to the Air Force, the decision to build the second site will be based on funding availability and will likely be made in the next few years. However, production of the second site will not begin until the first site has successfully completed operational testing. The program office expects the design of the second site to be very similar to the first, but on a smaller scale. If it is built, there will likely be little to no new technology development for the second site.

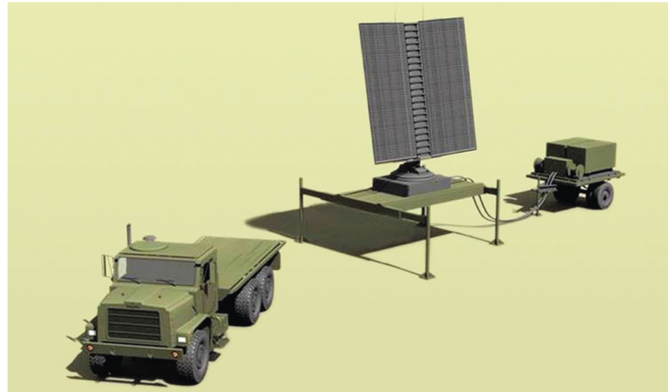
The Joint Space Operations Center (JSpOC) at Vandenberg AFB is acquiring a new data processing capability—JSpOC Mission System (JMS)—to process the increased volume of data expected from Space Fence. Currently, JMS is scheduled to become operational by December 2016, enabling input and processing of data from Space Fence to support its operational testing and initial capability. JMS is being developed as a Major Automated Information System in a separate acquisition program from Space Fence.

Program Office Comments

In commenting on a draft of this assessment, the program office noted that it conducted an integrated baseline review in November 2014, and full focus is now on holding the critical design review and construction. Independent technology readiness and manufacturing readiness assessments are planned to begin in January 2015, and should confirm full maturity. In addition, construction of the first radar site should begin in January 2015 with construction of the sensor site and power plant annex. The program continues to collaborate with the JMS program office to define the interface between the two systems, and an interface control document that takes into account Space Fence net-centric capabilities is being drafted. The program office also noted that Air Force Space Command actively monitors Space Fence Increment 1 progress while assessing its future impact on the space surveillance network. The decision to proceed with Increment 2 will rest on operational need and funds availability.

Three-Dimensional Expeditionary Long-Range Radar (3DELRR)

The Air Force's 3DELRR is being developed as a long-range, ground-based sensor for detecting, identifying, tracking, and reporting aircraft and missiles, including highly maneuverable and low observable targets. It is intended to provide real-time data and support a range of operations in all types of weather and terrain. It is being acquired to replace the Air Force's AN/TPS-75 radar systems, which are experiencing maintainability and sustainability issues.



Source: U.S. Air Force.

Concept | System development | Production

- Program start (5/09)
- Development start (9/14)
- GAO review (1/15)
- Design review (3/15)
- Low-rate decision (4/18)
- End operational test (6/19)
- Initial capability (5/20)

Program Essentials

Prime contractor: Raytheon
Program office: Hanscom AFB, MA
Funding FY15 to FY20:
R&D: $250.1 million
Procurement: $330.1 million
Total funding: $580.2 million
Procurement quantity: 11

Program Performance (fiscal year 2015 dollars in millions)

	As of	Latest 10/2014	Percent change
Research and development cost	NA	$417.1	NA
Procurement cost	NA	$971.0	NA
Total program cost	NA	$1,388.1	NA
Program unit cost	NA	$39.660	NA
Total quantities	NA	35	NA
Acquisition cycle time (months)	NA	132	NA

The 3DELRR entered system development in September 2014 with all of its critical technologies nearing maturity, but not yet demonstrated in a realistic environment. Prior to system development, the program took steps to reduce technical risk and program costs by conducting system-level competitive prototyping and analyzing the tradeoffs between costs and requirements. The 3DELRR program's remaining development risks may vary to some extent based on the design of the contractor selected for system development, although software integration will be a risk regardless of the contractor. The program office awarded its system development contract in October 2014, but contract performance has been delayed pending the resolution of issues raised in bid protests.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	●
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

3DELRR Program

Technology and Design Maturity

The 3DELRR program entered system development in September 2014 with all of its critical technologies approaching maturity. The program plans to fully mature its critical technologies through the system development phase by demonstrating them in a realistic environment. According to program officials, the critical technologies would vary based on the contractor selected for system development. While the program office awarded the system development contract in October 2014 to Raytheon, Lockheed Martin and Northrop Grumman protested the award of the contract. Performance of the contract has been suspended pending resolution of issues raised in bid protests.

While the 3DELRR program's specific development risks may vary to some extent based on the design of the contractor selected for system development, the program is tracking a number of overall development risks. For example, the 3DELRR has a software-intensive design, and software development was identified as a risk because of the system's potential integration challenges and re-use of code. In addition, the 3DELRR is expected to use a new semiconductor technology, which could pose cost or schedule risks. Specifically, the system is expected to use gallium nitride-based transmit/receive modules for the individual radiating elements key to transmitting and receiving electromagnetic signals, rather than the legacy gallium arsenide transmit/receive modules. While the use of gallium nitride may present some risks for the program, it has the potential to provide higher efficiency with lower power and cooling demands than legacy semiconductor technology.

Prior to the start of system development, the 3DELRR program conducted a number of risk reduction efforts in the technology development phase. For example, the program conducted system-level competitive prototyping, held preliminary design reviews with multiple contractors, and conducted capability demonstrations. According to program officials, these risk reduction efforts allowed the program to mature critical technologies, refine technical requirements and cost estimates, and assess manufacturing readiness.

Other Program Issues

DOD and the Air Force took steps to decrease the potential cost of the 3DELRR and ensure its affordability prior to entering system development. At the direction of senior DOD leadership, the program analyzed tradeoffs between cost and capability. As a result of this analysis, the Air Force revised the system's range and survivability requirements, among other attributes, which reduced the program's estimated cost.

Program Office Comments

The program office concurred with this assessment and provided technical comments, which were incorporated where appropriate.

VH-92A Presidential Helicopter Replacement Program

The Navy's VH-92A (formerly designated VXX) program provides new helicopters for executive transport of the President, Vice President, heads of state, and others. A successor to the terminated VH-71 program, VH-92A's fleet of 21 operational aircraft (includes trainers) and two test aircraft replaces 19 legacy VH-3D and VH-60N, two trainers, and two test aircraft. The program entered development in April 2014; the Navy awarded a development contract in May 2014. Until VH-92As are available, the Navy is extending legacy fleet availability.

Source: Sikorsky Aircraft Corporation.

Concept		System development			Production			
Material development decision (3/10)	Development start (4/14)	GAO review (1/15)	Design review (7/16)	Low-rate decision (1/19)	Operational test complete (3/20)	Initial capability (7/20)	Full-rate decision (5/21)	

Program Essentials

Prime contractor: Sikorsky Aircraft Corporation
Program office: Patuxent River, MD
Funding needed to complete:
- R&D: $2,342.9 million
- Procurement: $2,072.0 million
- Total funding: $4,414.9 million
- Procurement quantity: 17

Program Performance (fiscal year 2015 dollars in millions)

	As of	Latest 07/2014	Percent change
Research and development cost	NA	$2,646.0	NA
Procurement cost	NA	$2,072.0	NA
Total program cost	NA	$4,718.0	NA
Program unit cost	NA	$205.130	NA
Total quantities	NA	23	NA
Acquisition cycle time (months)	NA	75	NA

The VH-92A program is using an existing commercial aircraft and incorporating mature technologies. While no new technologies are involved, the government-provided fully configured mission communication system has yet to be tested in an aircraft. The number of design drawings will be finalized at the critical design review, in July 2016. To reduce risk, the program is using engineering development models to demonstrate installation of the VH-92A unique mission communication system and determine the placement of 14 additional antennas. Flight testing of the system's performance is scheduled to begin in May 2017. The program's schedule anticipates concurrent development testing and production; most aircraft will be under contract before test results are known. To reduce overall program risk, the Navy awarded a fixed-price incentive (firm target) contract for development.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	○
• Complete preliminary design review	○
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

VH-92A Program

Technology and Design Maturity

The VH-92A entered system development with its mission communication system (MCS), a new system that's technology is critical to the mission, approaching full maturity. While it's been tested in a laboratory, the full MCS has yet to be flown on board an aircraft. The program will modify a commercially available aircraft for the VH-92A using mostly upgraded technologies that are already on the legacy fleet. The sole exception is the MCS; according to the program office, some of its components will undergo minor modifications to integrate them into the new aircraft. One significant integration and design risk for the program is the installation of the 14 additional antennas on the airframe. Lockheed Martin, a subcontractor, is integrating the government-provided MCS with a modified Sikorsky S-92 airframe and conducting antenna co-site analysis to properly place the antennas and identify any interference issues. According to the program office, a fully configured mission communication system is scheduled for flight testing beginning in mid-2017.

The program does not plan to conduct a system-level preliminary design review until September 2015, or about 17 months after development start. The requirement to conduct this review was deferred until after development start. The number of design drawings required for the program will be finalized at the critical design review, currently planned for July 2016.

Production Maturity

The Navy is buying two engineering development and four system demonstration aircraft models. These assets will be used to demonstrate production readiness, as well as the design and maturity of the MCS. The initial engineering model was delivered to Lockheed Martin in the first quarter of 2015. It will undergo a series of tests including ice testing, before returning to Sikorsky in 2016. The low-rate initial production decision is currently scheduled for January 2019. A total of 12 units will be produced in two low-rate production lots. The remaining five units will be acquired in full-rate production. The program plans to utilize a concurrent development and production strategy, with nearly 80 percent of planned aircraft buy will be under contract before developmental testing results are made known. This runs the risk of costly retrofits to existing systems if problems are discovered late in testing. The program office conducted a schedule risk assessment in October 2014, and plans to do so annually.

Other Program Issues

In May 2014, the Navy awarded a fixed-priced incentive (firm target) contract with a target price of $1.24 billion to Sikorsky Aircraft Corporation, to support the VH-92A development effort. This contract type is designed to control costs and limit risk to the government. A target cost, target profit, profit adjustment formula, and maximum amount that may be paid to the contractor by the government, known as a ceiling price, were negotiated. The government and contractor share savings in the event of cost under-runs and they share cost (up to a point) in the event of over-runs. To ensure these negotiated terms are met, the program must maintain the stability of the requirements and design by limiting the number of approved changes. The program office has a change control process in place which requires three layers of review, of which the last two require senior leadership approval.

Program Office Comments

According to the program office, the program's acquisition strategy is based on a foundation of four key elements: a fixed-price incentive (firm target) contract; integrating mature components with no critical technology elements; using an in-production air vehicle; and maintaining the original airworthiness certification authority to certify the VH-92A configuration. During calendar year 2014, the program completed its acquisition and development milestones as planned. Further, the program office also noted that cost estimates remain unchanged from the baseline approved at the milestone B review. The VH-92A fleet of 21 operational aircraft, including training assets, and two test aircraft will replace 19 legacy VH-3D and VH-60N, two training and two test aircraft. The program is on track to complete its preliminary design review later this year. The program office also provided technical comments, which were incorporated as appropriate.

Warfighter Information Network-Tactical Increment 2 (WIN-T Inc 2)

WIN-T is the Army's high-speed and high-capacity tactical communications network. It connects units with higher levels of command, and is being fielded in several increments. We assessed the second increment, which is expected to provide the Army with an initial networking on-the-move capability. The third increment is now a software-only development effort that will provide critical software upgrades to support improved network capabilities for the first and second increments.

Source: U.S. Army.

Concept | **System development** | **Production**

Program/ development start (6/07)	Design review (2/08)	Low-rate decision (3/10)	Initial operational testing (5/12)	Follow-on operational test (5/13)	Initial capability (8/13)	Follow-on operational test (11/14)	GAO review (1/15)	Full-rate decision (5/15)

Program Essentials

Prime contractor: General Dynamics C4 Systems, Inc.
Program office: Aberdeen Proving Ground, MD
Funding needed to complete:
R&D: $20.2 million
Procurement: $9,610.3 million
Total funding: $9,630.5 million
Procurement quantity: 4,013

Program Performance (fiscal year 2015 dollars in millions)

	As of 10/2007	Latest 12/2013	Percent change
Research and development cost	$252.7	$297.1	17.6
Procurement cost	$3,675.0	$12,225.5	232.7
Total program cost	$3,927.7	$12,522.6	218.8
Program unit cost	$2.075	$2.353	13.4
Total quantities	1,893	5,323	181.2
Acquisition cycle time (months)	50	74	48.0

In May 2014, the Army was directed to update the WIN-T Increment 2 program's cost position and program baseline; changes from this decision are not reflected in the latest column above.

WIN-T Increment 2 entered production in March 2010 with mature critical technologies and, according to program office metrics, a stable design, but before bringing manufacturing processes under control. An August 2012 assessment of the program's manufacturing readiness levels indicated that these processes are now demonstrated and under control as the program approaches full-rate production. However, the program has struggled to demonstrate the required performance and reliability during operational testing and a full-rate production decision has been delayed twice. A third operational test, intended to confirm that deficiencies have been corrected, was concluded in November 2014. The final assessment of this test event is planned to complete by April 2015 in support of a May 2015 full-rate production decision.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• Release at least 90 percent of design drawings	▪▪▪▪
• Test a system-level integrated prototype	●
Manufacturing processes are mature	
• Demonstrate critical processes are in control	●
• *Demonstrate critical processes on a pilot production line*	
• Test a production-representative prototype	●

● Knowledge attained ▪▪▪▪ Information not available
○ Knowledge not attained *Not applicable*

WIN-T Increment 2 Program

Technology and Design Maturity

All 15 WIN-T Increment 2 critical technologies were mature by its March 2010 production decision. In August 2012, an independent manufacturing readiness assessment prepared by the Army concluded that the prime contractor had achieved an acceptable level of technology maturity to continue to full rate production. According to the WIN-T program, it has integrated and tested its key technologies and subsystems, demonstrating that the system's design is capable of working as intended. The program office does not track the metric we use to measure design maturity, the number of releasable drawings, as WIN-T is primarily an information technology integration effort. Instead, design performance is measured through a series of component, subsystem, configuration item, and network-level tests designed to demonstrate performance at increasing levels of system integration. Design stability is assessed through problem-tracking report trends.

Production Maturity

The WIN-T Increment 2 program began production in March 2010 and began testing a production-representative prototype in March 2011. The program indicates that its manufacturing processes—as determined by an Army manufacturing readiness assessment—are now in control, but were not demonstrated or brought in control at production start. However, the program has struggled to demonstrate the required performance and reliability of several key configuration items during operational testing, which has delayed the program's entry into full rate production. A follow-on operational test in May 2013 showed improved reliability and performance compared with a previous operational test, but revealed that deficiencies remained. In particular, while the majority of the program's components have now been assessed as operationally effective and suitable, three were assessed as not operationally effective, and two were assessed as not operationally suitable due to complexity of operations and reliability problems. Consequently, the milestone decision authority delayed a full rate production decision until the Army completes additional follow-on developmental and operational testing, and confirms that deficiencies have been corrected. Two developmental tests conducted in February and June 2014 showed improved reliability and performance. A follow-on operational test was completed in November 2014 and results from this test are expected to be available to support a full rate production decision in May 2015.

Other Program Issues

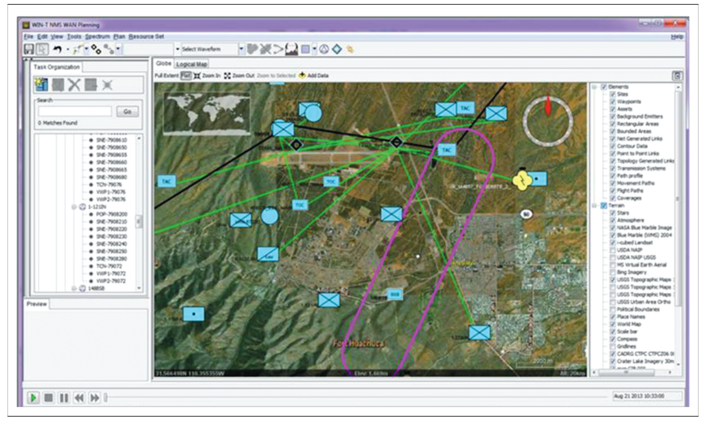
According to program documentation, fiscal constraints forced the Army to adjust its funding priorities and requirements, and led to the restructuring of the overall WIN-T effort. The Army eliminated the requirements for WIN-T Increment 3 unique hardware production, but retained the software development efforts which will provide WIN-T Increment 2 with improved capabilities in fiscal year 2016. Additional operational testing of the upgraded Increment 2 system to verify performance enhancements is expected to take place after the full rate production decision. The Army also plans to increase procurement quantities of WIN-T Increment 2 configuration items to complete WIN-T capability set fielding requirements previously slated for WIN-T Increment 3.

Program Office Comments

In commenting on a draft of this assessment, the program office noted that in mid-January 2015, it received an emerging results brief from the Army Test and Evaluation Command (ATEC) that addresses findings from the November 2014 follow-on operational test. The emerging results indicate that ATEC has determined the program is effective and suitable. As of January 2015, the survivability assessment is still under analysis. Final Director of Operational Test and Evaluation results have not yet been issued, but are expected prior to the full-rate production decision scheduled for May 2015.

Warfighter Information Network-Tactical Increment 3 (WIN-T Inc 3)

WIN-T is the Army's high-speed and high-capacity communications network. It connects units with higher levels of command, and is being fielded in several increments. Increment 3, the increment assessed here, provides software enhancements to the Army's communication for improved network capacity and robustness. This software will be used to update and enhance hardware procured for Increments 1 and 2.



Source: U.S. Army.

Concept | **System development/Production**

- Program/ development start (7/03)
- Design review (12/13)
- Restructure finalized (9/14)
- GAO review (1/15)
- Limited user test complete (5/16)

Program Essentials

Prime contractor: General Dynamics C4 Systems, Inc.
Program office: Aberdeen Proving Ground, MD
Funding needed to complete:
R&D: $152.9 million
Procurement: $0.0 million
Total funding: $152.9 million
Procurement quantity: 0

Program Performance (fiscal year 2015 dollars in millions)

	As of 05/2009	Latest 09/2014	Percent change
Research and development cost	$2,846.3	$1,996.7	-29.8
Procurement cost	$14,488.9	$0.0	-100.0
Total program cost	$17,335.1	$1,996.7	-88.5
Program unit cost	$4.978	NA	NA
Total quantities	3,482	0	-100.0
Acquisition cycle time (months)	165	NA	NA

In May 2014, the Under Secretary of Defense for Acquisition, Technology, and Logistics approved the Army's request to restructure the WIN-T Increment 3 program, which eliminated the requirements for hardware but retained the software development efforts to update WIN-T Increments 1 and 2. As a result, only 9 of the program's former 18 critical technologies remain. The remaining technologies are intended to improve network operations and increase the throughput available for satellite communications. The Army plans to continue software development and testing through fiscal year 2015 and 2016, respectively. Upon completion, WIN-T Increment 3 will cease to be an independent acquisition program and the WIN-T Increment 2 program will complete the software integration, operational testing, and fielding.

Attainment of Product Knowledge

As of January 2015

Resources and requirements match	
• Demonstrate all critical technologies in a relevant environment	●
• Demonstrate all critical technologies in a realistic environment	●
• Complete preliminary design review	●
Product design is stable	
• *Release at least 90 percent of design drawings*	
• *Test a system-level integrated prototype*	
Manufacturing processes are mature	
• *Demonstrate critical processes are in control*	
• *Demonstrate critical processes on a pilot production line*	
• *Test a production-representative prototype*	

● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

WIN-T Increment 3 Program

Technology Maturity

Based on the results of a November 2013 Army configuration steering board and a subsequent May 2014 acquisition decision memorandum, the Army de-scoped and restructured the program, reducing the number of critical technologies from 18 to 9. This decision eliminated the technologies associated with hardware development, including the digital transceiver and antennas. As a result, WIN-T Increment 3 is now a software-only development program, with development continuing through fiscal year 2015, and testing planned into fiscal year 2016. The remaining technologies improve network operation tools that ensure management of voice, data, and internet transport networks by simplifying network management, increasing automation, and boosting throughput and robustness. While the program office considers these technologies mature, some have not been demonstrated through testing. The WIN-T Increment 2 program will complete the integration, operational testing, and fielding of the WIN-T Increment 3 software. According to the program office, operational testing will take place in fiscal year 2016.

Design and Production Maturity

The program office does not track the metric we use to measure design maturity—the number of releasable drawings—as WIN-T Increment 3 is a software-only development program. Instead, design performance is measured using earned value management that tracks the progress of work completed against projected cost and schedule estimates. According to the program office, it is not currently meeting the projected estimates. The program also uses software growth as a metric to assess its progress and maturity.

The Army's restructure of the WIN-T Increment 3 program eliminated its unique hardware development, and, as a result, no production is required. The procurement funding that would have been used for WIN-T Increment 3 hardware will now be used to procure additional WIN-T Increment 2 hardware and complete the WIN-T capability set fielding.

Other Program Issues

According to program documentation, the restructuring of the WIN-T program was due to fiscal constraints that forced the Army to adjust its funding priorities and requirements. The program will continue submitting defense acquisition executive summaries and selected acquisition reports until its capabilities are incorporated into WIN-T Increments 1 and 2. After the program provides the capabilities planned to be delivered in fiscal year 2016, it will cease to be an independent acquisition program.

Program Office Comments

The program office concurred with this assessment and provided technical comments, which were incorporated where appropriate.

Amphibious Combat Vehicle (ACV)

The Marine Corps' Amphibious Combat Vehicle (ACV) is a potential successor program to the terminated Expeditionary Fighting Vehicle. The ACV is intended to transport Marines, including ship to shore operations, to secure a beachhead. According to officials, in July 2012 the Marine Corps completed an ACV analysis of alternatives (AOA) in which high water speed was a desired capability, but not a primary requirement. Subsequently, the Marine Corps conducted further analysis to explore cost and capability trades associated with a high water speed capability.

Source: U.S. Marine Corps.

Current Status

According to officials, there are several key requirements for the ACV including improved protection and mobility over legacy vehicles. Subsequent to the July 2012 AOA, Marine Corps officials directed a study of high water speed, considered a critical need for amphibious assault, which determined high water speed was technically feasible but not without unacceptable tradeoffs. As a result of this study, the Marine Corps initiated three separate acquisition efforts to upgrade existing assets; complement and partially replace those assets to mitigate capability shortfalls; and further explore development of a high water speed capability. According to officials, one effort consists of on-going survivability upgrades to 392 Assault Amphibious Vehicles (AAV), the vehicle currently used by the Marine Corps for amphibious assault. These efforts are intended to keep the AAV in service until 2035.

According to officials, the second effort consists of repurposing the previously suspended Marine Personnel Carrier (MPC), a wheeled vehicle, as the ACV program and will proceed in two increments. The first increment will develop an ACV with improved troop protection and limited amphibious ability, and the second increment, initiation of which is dependent on the success of the first, will improve that amphibious ability to allow self deployment for ship-to-shore operations, as well as other variants such as a command and control and a recovery variant. The third and final effort focuses on technology exploration to attain a high water speed capability. Officials added that contracts to explore technologies for this effort are already underway. Development start for the first increment of the ACV program is planned for November 2015.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $2,012.6 million
Research and development: $725.1 million
Procurement: $1,178.7 million
Quantity: 36 (development), 204 (procurement)

Next Major Program Event: System development start, November 2015

Program Office Comments: The ACV program remains on schedule and budget to provide initial operational capability to operational forces in 2020. The program office also provided technical comments, which were incorporated where deemed appropriate.

B-2 Defensive Management System Modernization (B-2 DMS)

The Air Force's B-2 DMS modernization program, which entered technology development in 2011, is expected to upgrade the aircraft's 1980s-era analog defensive management system to a digital capability. The program intends to improve the frequency coverage and sensitivity of the electronic warfare suite, update pilot displays, and enhance in-flight replanning capabilities to avoid unanticipated air defense threats. It also expects to improve the reliability and maintainability of the DMS system and the B-2's readiness rate.

Source: U.S. Air Force.

Current Status

The program is leveraging subsystems from other programs but most will need to be repackaged and nuclear hardened to meet B-2 specific requirements. A preliminary technology assessment identified two critical technologies that are not yet mature-band 4 antennas and a geo-location software algorithm. Both are expected to be nearing full maturity at system development start. The prime contractor conducted competitions for three key subsystems-antennas, processors, and electronic support measures. Competitive prototyping was also conducted for the antennas, which are not yet technically mature. A preliminary design review was completed in September 2014. The program is investing heavily in the technology development phase to reduce risks prior to entering system development and expects to invest almost 50 percent of the total expected development funds during this phase. Several planned activities, such as ordering flight test hardware and extensive software coding, are usually associated with system development.

Since entering technology development in 2011, estimated costs for the program have increased and milestones have been delayed. We previously reported on the program's rapid acquisition initiative which was to reduce acquisition times by two to three years and lower costs up to $500 million. According to program officials, this initiative has been curtailed. Based on the latest estimate, the total acquisition cost has increased by $301.2 million since 2011 to reflect changes in software functionality, flight test plans, and the need for additional ground and test related hardware. The program now plans to enter development in July 2015, a delay of 15 months, and initial operational capability was delayed two years to 2021. Program officials attribute this delay to funding reductions for fiscal years 2013 to 2015.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $2,305 million
Research and development: $1,617 million
Procurement: $688 million
Quantity: 20

Next Major Program Event: System development start, July 2015

Program Office Comments: In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

Common Infrared Countermeasures (CIRCM)

The Army's CIRCM, the next generation of the Advanced Threat Infrared Countermeasures (ATIRCM), will be used with a missile warning system and a countermeasure dispenser capable of employing expendables, such as flares and chaff, to defend aircraft from infrared-guided missiles. The CIRCM program will develop a laser-based countermeasure system for rotary-wing, tilt-rotor, and small fixed-wing aircraft across DOD. CIRCM is one of three subprograms that make up the ATIRCM/CMWS major defense acquisition program.

Source: © 2011 BAE Systems (left); Northrop Grumman (right).

Current Status

The Army entered the technology development phase in January 2012 by awarding two contracts to mature CIRCM critical technologies. An Army technology readiness assessment assessed nine critical technologies and determined that these were approaching maturity leading up to system development, which is now planned for May 2015. The Army recently completed the exit criteria to conclude the technology development phase and, according to the program office, all criteria were successfully completed. Examples of exit criteria are that the critical technologies must be demonstrated in at least a relevant environment, and the system must demonstrate that it is on track to meet reliability requirements in the development phase. The program office believes CIRCM is performing well in the current technology development phase.

The Army planned to conduct a full and open competition for system development in December 2014, and awarded one contractor a cost-plus-fixed-fee/firm-fixed-price contract with technical performance incentives focused on achievement of weight and reliability goals. Pursuant to a recommendation by the Office of the Secretary of Defense, the program limited competition to the two existing contractors from the technology development phase to avoid duplication of cost and development efforts, and because market research indicated that only the current vendors were interested in the development effort. The contract type was changed to also include fixed-price incentive along with cost-plus-fixed-fee and firm-fixed-price payment terms. According to the program office, these changes and the associated administrative requirements delayed the planned development contract award by five months.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total Program: $3,625.2 million
Research and development: $794.4 million
Procurement: $2,830.8 million
Quantity: 1,076

Next Major Program Event: System development start, May 2015

Program Office Comments: In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

DDG 51 Flight III Destroyer (DDG 51 Flight III)

The DDG 51 Flight III destroyer will be a multimission ship designed to operate against air, surface, and subsurface threats. As compared to existing Flight IIA ships, Flight III ships will provide increased ballistic missile and area air defense capabilities. Planned configuration changes for Flight III include replacing the SPY-1D(V) radar—currently used on Flight IIA ships—with the new Air and Missile Defense Radar (AMDR). The Navy plans to acquire a total of 22 Flight III ships, beginning with a lead ship in fiscal year 2016.

Source: Bath Iron Works.

Current Status

The Navy is undertaking Flight III detail design activities in fiscal 2015 concurrent with AMDR development—a strategy that could disrupt detail design activities as AMDR attributes become more defined. The Navy identifies AMDR integration as posing technical, cost, and schedule risks to the Flight III program. In addition to AMDR, Flight III changes include upgrades to the ships' cooling and electrical systems and other configuration changes intended to increase weight and stability margins. The Navy reports that a prototype of the cooling system is in operation at the vendor's factory and is undergoing environmental qualification testing. However, the Navy identifies cost and schedule risks to the Flight III program associated with these cooling upgrades. The electrical system upgrades include changes to the distribution system to add and modify switchgear and transformers based on the system installed on LHA 6.

The Navy plans to use engineering change proposals to the existing Flight IIA multiyear procurement contracts to construct the first three Flight III ships rather than establish new contracts for detail design and construction. The Navy has allotted 17 months to mature the Flight III detail design ahead of the planned solicitation for these proposals and plans to award construction of the first Flight III ship in fiscal 2016, with two follow-on ships in fiscal 2017. To support this, per DOD policy the Navy sought congressional approval in 2014 to transfer funds and begin detail design in the fourth quarter of fiscal 2014. However, this request was denied, postponing detail design start by several months. In September 2014, the Navy notified Congress that a delayed detail design start may prompt it to delay the introduction of AMDR until fiscal 2017.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $42,829.0 million
Research and development: $3,990.0 million
Procurement: $38,839.0 million
Quantity: 22 (procurement)

Next Major Program Event: Award of first Flight III engineering change proposal, fiscal year 2016.

Program Office Comments: According to the Navy, AMDR and Flight III development continue on schedule to support implementation on a fiscal 2016 ship. Recent completion of critical design review for AMDR hardware mitigates potential that Flight III detail design will be impacted. The Navy plans to report additional details of this strategy to Congress in early 2015.

F-15 Eagle Passive / Active Warning and Survivability System (F-15 EPAWSS)

The Air Force's F-15 EPAWSS program is intended to upgrade the electronic warfare system on fielded F-15 aircraft. The program seeks to improve the aircraft's internal self-protection electronic warfare systems to enable operations in current and future threat environments. The program is also expected to improve the F-15's survivability by enhancing its ability to detect, identify, locate, deny, degrade, disrupt, and defeat air and ground threat systems.

Source: U.S. Air Force.

Current Status

In June 2014, the Under Secretary of Defense for Acquisition, Technology, and Logistics approved the program's release of a request for proposal for the technology maturation and risk reduction phase, and directed the program to enter the formal acquisition process and begin at its entry into technology development, expected in July 2015. The program plans to seek a waiver from competitive prototyping requirements and intends to conduct a preliminary design review before starting system development in fiscal year 2016. The Air Force is utilizing a sole source system integrator contracting approach with the F-15 manufacturer, who will competitively select and then integrate an electronic warfare system that meets requirements.

The Air Force plans to leverage non-developmental electronic warfare technologies and components, currently used in other Air Force and Navy aircraft, to create a wide bandwidth digital electronic warfare system capable of protecting the F-15 aircraft against advanced enemy threats. The Air Force identified the F-15 EPAWSS digital receiver technology—both the hardware and the associated software—as a critical technology that the program does not currently intend to fully mature prior to the start of system development. According to program officials, a key risk is the integration of the electronic warfare system with all other on-board and off-board systems to properly operate in its intended environment. Also, a July 2014 program office technical assessment cited the scope of software development and the availability of test resources to support ground and flight testing as high risk areas. Other risk areas include limited in-house simulation capabilities and potential incompatibility with other F-15 radio frequency systems, which could require redesign and additional testing.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $3,499.3 million
Research and development: $582.5 million
Procurement: $2,916.8 million
Quantity: 392

Next Major Program Event: Milestone A defense acquisition board review, July 2015

Program Office Comments: According to the Air Force, the program office continues to execute a risk management process and an ongoing characterization contract to identify and actively mitigate risks. The strategy to leverage mature non-developmental components is a key element of the program's efforts to drive positive schedule, affordability, and program outcomes.

Fleet Replenishment Oiler (T-AO(X))

The Fleet Replenishment Oiler (T-AO(X)) program is intended to replace the Navy's 15 existing T-AO 187 Class Fleet Oilers, which are nearing the end of their service lives. Its primary mission is to provide replenishment of bulk petroleum products, dry stores/packaged cargo, fleet freight, mail, and personnel to other vessels while underway. The Navy plans to procure the first T-AO(X) in fiscal year 2016 and the remaining 16 ships at a rate of one per year beginning in fiscal year 2018.

Source: U.S. Navy. Notional Concept T-AO(X)

Current Status

The Navy has completed cost and capabilities trade studies, which suggest that T-AO(X) will be able to meet minimum capability requirements within projected costs utilizing existing ship designs and technologies. The Navy plans to employ military unique systems for specific functions, such as underway replenishment. According to an October 2014 technology readiness assessment, the program's three critical technologies—associated with the ship's underway replenishment system known as Electric Standard Tension Replenishment Alongside Method (E-STREAM)—are fully mature based on the results of land-based and at-sea prototype testing. The most notable of these technologies, Heavy E-STREAM, allows the transfer of cargo at double the standard speed or, alternatively, double the standard load weight. These technologies are required to meet the more robust requirements for underway replenishment associated with the new Ford-class aircraft carriers. The program was granted a waiver for the requirement to conduct competitive prototyping prior to system development start.

According to Navy officials, under the revised T-AO(X) acquisition strategy, the Navy anticipates competitively awarding a fixed-price incentive type contract in fiscal year 2016 for lead ship detail design and construction with options for five follow-on ships at a rate of one per year beginning in fiscal year 2018. Navy officials indicated that the remaining ships will also be acquired at a rate of one ship per year under two additional contracts. The Navy has identified industrial base instability as a program execution risk, which may compel lead ship construction to begin prior to completion of three-dimensional product modeling design—a strategy that has caused cost growth and schedule delays in other Navy programs and is inconsistent with best practices.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program (fiscal years 2011-2019): $1,823.3 million
Research and development (fiscal years 2011-2014): $55.4 million
Procurement (fiscal years 2016-2019): $1,767.9 million
Quantity: 3

Next Major Program Event: System development start, May 2016

Program Office Comments: In commenting on a draft of this assessment, the program office disagreed that industrial base instability may result in premature start to lead ship construction. According to the program office, before construction start is authorized, the shipbuilder must successfully complete a production readiness review to demonstrate mature ship design and adequate production planning.

Improved Turbine Engine Program (ITEP)

The Army's Improved Turbine Engine Program (ITEP) is developing a replacement engine for the Black Hawk and Apache helicopter fleets. The new engine is intended to have increased power, performance, and fuel efficiency; enhanced reliability; increased service life; and a lower maintenance burden than current engines. The increased fuel efficiency is expected to lessen the need for refueling by providing increased operational range.

Source: U.S. Army.

Current Status

In November 2012, the Under Secretary of Defense for Acquisition, Technology and Logistics approved the Army's plans to enter the material solution analysis phase and to conduct an analysis of alternatives. The Army awarded contracts to two separate vendors to mature technologies through testing of engine demonstrators and prototypes under the Advance Affordable Turbine Engine program. Both of these vendors have completed numerous systems engineering reviews as well as component tests in a relevant environment. The Army is planning to bypass an official technology development phase and enter the acquisition process at development in the second quarter of 2018, after completing a system-level preliminary design review in fiscal year 2017. An Independent Review Team identified three critical technologies, advanced inlet particle separator, compressor/advanced aerodynamics, and hybrid bearings, all of which it reports as approaching full maturity.

The engine's initial request for proposals for the preliminary design review contract is expected to be released in the third quarter of fiscal year 2015. Following contract completion and a system level preliminary design review, the Army will release a second request for proposals for the system development contract in the third quarter of fiscal year 2017. The Army plans to limit competition for this contract to the two preliminary design contract awardees and down select to a single vendor for system development.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $9,406.9 million
Research and development: $1,726.1 million
Procurement: $7,680.8 million
Quantity: 27 (development), 6,215 (procurement)

Next Major Program Event: Preliminary design review request for proposals, third quarter fiscal year 2015

Program Office Comments: The program also provided technical comments, which were incorporated as appropriate.

Indirect Fire Protection Capability-Increment 2 (IFPC Inc 2)

The Army's IFPC Inc. 2 consists of three blocks, each a separate major defense acquisition program, to detect, assess, and defend against threats from rockets, artillery, mortars, cruise missiles, and unmanned aircraft. The first IFPC increment, fielded in 2004, provides a short-range capability to counter rockets, artillery, and mortar threats. IFPC Inc. 2, Block 1 establishes the capability to counter cruise missiles and unmanned aircraft. The remaining blocks add to and extend the range and capability.

Source: IFPC Inc 2 Product Office.

Current Status

In March 2014, IFPC Inc. 2 received approval to enter the technology development phase and received a waiver for the competitive prototyping requirement on the basis that the cost of prototypes exceeds the expected life-cycle benefits. The Army determined that competing prototypes for the primary developmental component, the multi-mission launcher, may improve software productivity and fabrication efficiency, but would add an estimated $215.2 million in costs and result in only $10.1 million in life-cycle savings. IFPC Inc. 2's current strategy is for the Army to build its own prototypes at the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), which, according to program officials, is held to the same industry reporting and accounting standards as contractors, allows access to accounting tools that enable them to track progress and performance, and costs up to 42 percent less than developing prototypes through a contractor.

As of November 2014, program officials stated that IFPC Inc. 2 has completed its system requirements and system functional reviews and has launched three different missiles from the multi-mission launcher prototype. It is now preparing for the start of system development in June 2016 by conducting a cost and benefit analysis to determine the best approach to move from development into production. Currently, IFPC Inc. 2 is planning to use AMRDEC, but it is also preparing to support other options. Program officials are pursuing a contract approach that will allow IFPC Inc. 2 to use AMRDEC for initial production or, allow the contract to expire with the end of development, and use full and open competition, a public-private partnership, or another arrangement to begin production.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $2.6 billion
Research and development: $517 million
Procurement: $2.0 billion
Quantity: 8 (development), 336 (procurement)

Next Major Program Event: Preliminary design review, September 2015

Program Office Comments: In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

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Joint Air-to-Ground Missile (JAGM)

The Joint Air-to-Ground missile is an Army-led program with joint requirements from the Navy and Marine Corps. The missile is designed to be air-launched from helicopters and unmanned aircraft systems to target tanks; light armored vehicles; missile launchers; command, control and communications vehicles; bunkers; and buildings. It is intended to provide line-of-sight, beyond line-of-sight, fire-and-forget, and precision attack capabilities in day, night, and adverse weather conditions. JAGM will replace all Hellfire missile variants.

Source: U.S. Army.

Current Status

The Army restructured JAGM in early 2012, extending its technology development by more than two years to explore alternative acquisition strategies, refine requirements, and consider more affordable solutions. As a result, the Army plans to use an evolutionary acquisition strategy with modular and open systems architecture to insert upgrades, mature technologies, and software updates without a major redesign. Also, the program determined that it could meet the requirements using some existing technologies-a Hellfire motor, warhead, and electronics-coupled with a newly developed guidance system. In October 2014, the Under Secretary of Defense for Acquisition, Technology, and Logistics approved the release of the request for proposals for the system development contract with options for low-rate production. According to program officials, this request for proposals is scheduled for release in the second quarter of fiscal year 2015, followed by the start of system development in the last quarter of fiscal year 2015. The Army plans to conduct a full and open competition and award a firm-fixed-price contract to a single entity.

During the extended technology development phase, prototyping was used to mature technologies and designs from two contractors. Each contractor completed a system level preliminary design review and participated in flight tests. In addition, a revised technology readiness assessment was completed in September 2013 that eliminated unnecessary technologies and revalidated the need to mature the remaining critical technologies. The program plans to enter system development with four critical technologies—the seeker dome, sensor platform, as well as sensor and mission software packages—all approaching maturity.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total Program: $3,900.4 million
Research and development: $774.7 million
Procurement: $3,125.6 million
Quantity: 20,492

Next Major Program Event: System development start, fourth quarter fiscal year 2015

Program Office Comments: According to program officials, the Army plans to enter a two year engineering and manufacturing development phase that will qualify the JAGM system on threshold aircraft and the production line as well as and complete initial operational test and evaluation. The program office also provided technical comments, which were incorporated where appropriate.

Joint Surveillance Target Attack Radar System Recapitalization (JSTARS Recap)

The JSTARS system is a manned airborne Battle Management Command and Control (BMC2) system providing near real-time surveillance and targeting information on moving and stationary ground targets. The Air Force's JSTARS Recap program is an effort to replace aging, legacy JSTARS aircraft initially fielded in the early 1990s. The JSTARS Recap acquisition program seeks to greatly reduce aircraft operating and sustainment costs, replace and improve JSTARS functionality, and minimize development and integration costs.

Source: U.S. Air Force.

Current Status

The program has conducted preliminary market research and technical planning for recapitalizing the JSTARS fleet and intends to use an in-production, commercial-business jet integrated with a sophisticated surface search radar, BMC2, and broad-spectrum communication subsystems. The program plans to deliver an adaptable, open architecture solution which aims to reduce future upgrade costs and increase competition across the JSTARS Recap lifecycle. According to the program office and its draft acquisition strategy, a materiel development decision review is planned for February 2015. Shortly thereafter, the program anticipates awarding technology maturation and risk reduction contracts for up to three contractor teams. These teams will demonstrate prototypes of the BMC2, radar, and communication subsystems considered high system integration risks prior to starting development. The program has not identified any immature technologies and stated that all major subsystem hardware, and the majority of the BMC2 software, currently exist and have been fielded. However, these subsystems do not currently exist as a fully functional, integrated JSTARS Recap system, and will need to be integrated during development. The program plans to conduct systems engineering technical reviews and preliminary design reviews prior to starting development. The program will conduct a post-milestone B final preliminary design review after development begins. In our previous work, we have found that acquisition programs that successfully complete a system-level preliminary design review prior to starting development typically have better cost and schedule outcomes. Initial operational capability for JSTARS Recap is expected in the fourth quarter of fiscal year 2023.

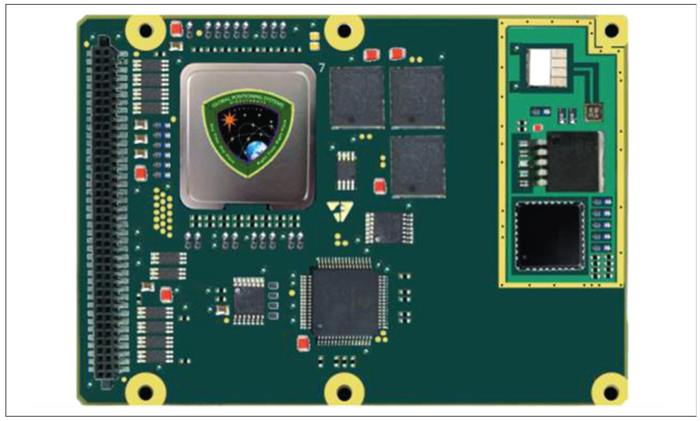
Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $6,403.3 million
Research and development: $2,391.4 million
Procurement: $4,101.9 million
Quantity: 17

Next Major Program Event: Materiel development decision, February 2015

Program Office Comments: In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

Military GPS User Equipment (MGUE), Increment 1

The Air Force's MGUE program plans to develop GPS receivers compatible with the military's next-generation GPS signal, Military-Code. The modernized receivers are to provide U.S. Forces with enhanced position, navigation, and time capabilities, while improving resistance to existing and emerging threats, such as jamming. The program is to be completed in two increments. Increment 1, assessed here, leverages technologies from the Modernized User Equipment (MUE) program to develop two variants and begin development of the Common GPS Module.



Source: U.S. Air Force.

Current Status

In April 2012, the Air Force initiated technology development of MGUE Increment 1 receivers under a traditional DOD acquisition strategy that included separate development and production decisions. In February 2014, the Under Secretary of Defense for Acquisition, Technology, and Logistics approved modification of the strategy and directed the Air Force to develop an amended plan to accelerate development and fielding of the receivers. The Air Force believes this approach will enable the military services to meet congressional direction to generally procure only M-code capable equipment after fiscal year 2017.

The subsequent acquisition strategy proposed by the Air Force adds software risk reduction efforts and accelerates security certification efforts. It also replaces a formal system development phase with a tailored one to allow for a combined system development and production decision in September 2015. Also, it more than halves the time allotted for integration and operational testing, reducing it by about 2.5 years.

According to a November 2014 independent technology readiness assessment, the military-code acquisition engine, military-code cryptography, and selective availability/anti-spoofing module cryptography critical technologies are fully mature, with the anti-spoofing and anti-tamper technologies approaching maturity. In addition, DOD's test authority has stated that technical maturity has not yet been demonstrated. Plans call for full maturity by the combined decision. Indications are that the program does not plan to hold a critical design review, which is typically when design stability is evaluated, manufacturing processes identified, and producibility assessments conducted. Our best practices work has shown that proceeding into production without the levels of knowledge achieved by demonstrating technology, design, and production maturity, increases risk of cost growth and schedule delays.

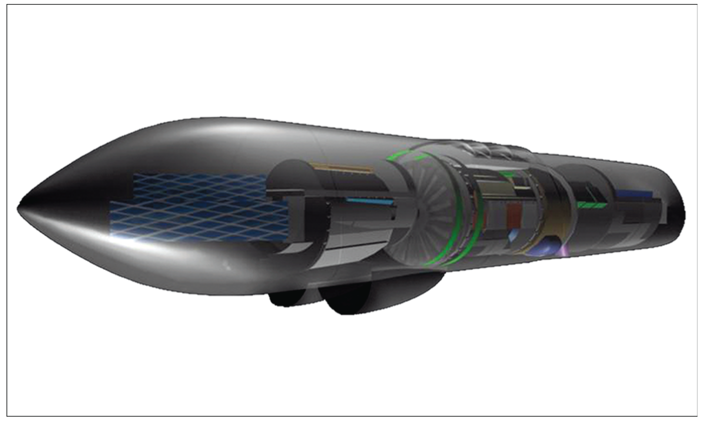
Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $1,738.3 million
Research and development: $1,738.3 million
Procurement: N/A
Quantity: N/A

Next Major Program Event: System development and production decision, September 2015

Program Office Comments: According to the program office, the acquisition strategy utilizes multiple suppliers to lower costs. The program is driving to field capability as soon as possible, and the independent assessment concluded critical elements are on track for the combined development and production decision.

Next Generation Jammer (NGJ)

The Navy's Next Generation Jammer (NGJ) is being developed as an external jamming pod system fitted on EA-18G Growler aircraft. It will replace the ALQ-99 jamming pod system and provide enhanced airborne electronic attack capabilities to disrupt and degrade enemy air defense and ground communication systems. The Navy plans to field capabilities in three increments for different radio frequency ranges, beginning with Increment 1 (mid-band) in 2021, with Increments 2 and 3 (low- and high-band) to follow. We assessed Increment 1.



Source: U.S. Navy.

Current Status

In July 2013, DOD approved NGJ Increment 1's entry into technology development, but its start was delayed by a bid protest. In January 2014, the Navy affirmed a $280 million technology development contract award to Raytheon after GAO sustained portions of BAE Systems' bid protest. Program officials state that the protest resulted in a 6 month delay to the program. The start of system development is now planned for February 2016 and the system's initial operational capability is delayed until 2021. Prior to the bid protest, the Navy completed a 33-month technology maturation phase during which four contractors competitively prototyped technologies and subsystems for Increment 1. The program currently has seven identified critical technologies-transmit/receive modules, circulators, apertures for two separate arrays, and a power generation system-all of which are expected to be approaching full maturity by the start of system development.

The Navy has identified four overarching risks for the NGJ Increment 1 program-meeting weight and power requirements, integrating the jamming pods with the aircraft, and maturing critical technologies. According to program officials, they have developed strategies to mitigate these risks, including introducing a weight management control plan; developing power generation prototypes; refining aircraft-pod integration requirements; and monitoring technology maturation plans. In June 2014, the Navy completed two systems engineering reviews on the integration of the NGJ with the EA-18G aircraft and the program plans to conduct a preliminary design review in September 2015, five months before the start of system development.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $6,284 million
Research and development: $2,830 million
Procurement: $3,450 million
Quantity: 8 (development), 114 (procurement)

Next Major Program Event: System development start, February 2016.

Program Office Comments: In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

Offensive Anti-Surface Warfare (OASuW)

The Offensive Anti-Surface Warfare (OASuW) Increment 1 is a Navy-led program that plans to leverage previous technology demonstration efforts to field an air-launched, long-range, anti-surface warfare missile. The program is using an accelerated acquisition model. It plans to field an early operational capability on Air Force B-1 bombers in 2018 and Navy F/A-18 aircraft in 2019. DOD is currently developing requirements for Increment 2, which could include air-, surface-, or sub-surface launched systems.

Source: Lockheed Martin.

Current Status

The OASuW Increment 1 program was initiated in fiscal year 2013 in response to an urgent operational need for an improved air-launched, anti-surface warfare capability. The program builds upon the Defense Advanced Research Projects Agency's (DARPA) Long-Range Anti-Ship Missile (LRASM) program and the Air Force's Joint Air-to-Surface Standoff Missile-Extended Range (JASSM-ER) program. Under the LRASM program, DARPA and the Navy conducted two demonstrations using modified JASSM-ER missiles, and although the missiles hit their targets, the testing was limited and not intended to be operationally realistic. In February 2014, the Under Secretary of Defense for Acquisition, Technology, and Logistics approved an accelerated acquisition approach for the OASuW Increment 1 program consisting of five decision points that align with key systems engineering reviews and test events. This approach will also use an integrated developmental and operational test program and will not include a formal, separate initial operational test and evaluation period.

Schedule is the key driver for the program because of the urgent need. However, the program's accelerated approach entails certain risks. For example, the program's eight critical technologies—which include hardware and software related to targeting and low-altitude flight—are not all expected to be demonstrated in a realistic environment until the critical design review in 2016. Also, this approach includes concurrent system-level testing and production, which can increase the risk of late design changes.

DARPA competitively awarded the first LRASM contract in 2009, but subsequent contracts to complete missile development and production have been, and are planned to be, awarded on a sole source basis. The Navy plans to pursue a competitive acquisition strategy for OASuW Increment 2.

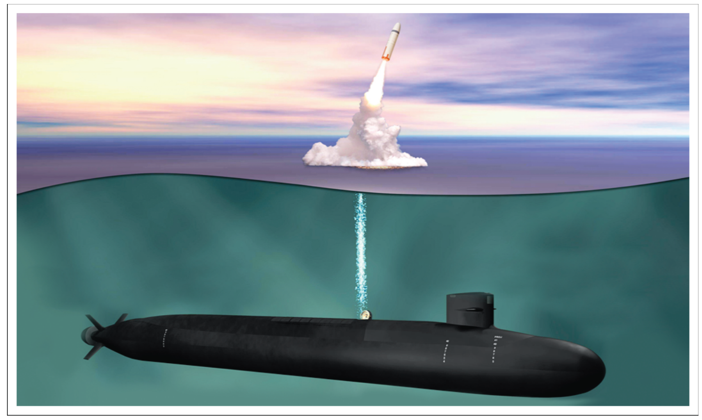
Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $1,525.2 million
Research and development: $1,189.6 million
Procurement: $335.6 million
Quantity: 110

Next Major Program Event: Critical design review, February 2016

Program Office Comments: In commenting on a draft of this assessment, the program office stated its strategy uses an integrated and concurrent design, integration, and test program to meet the accelerated schedule. The knowledge point reviews, which they define differently than GAO, are meant to manage this timeline and concurrency. The program intends to meet statutory requirements associated with milestone B at its third knowledge point in fiscal year 2016.

Ohio-Class Replacement (OR)

The Navy's Ohio-class Replacement (OR) will replace the current fleet of Ohio-class ballistic missile submarines (SSBNs) as they begin to retire in 2027. The Navy began technology development in January 2011 in order to avoid a gap in sea-based nuclear deterrence between the Ohio-class's retirement and the production of a replacement. The Navy is working with the United Kingdom to develop a common missile compartment for use on OR and the United Kingdom's replacement SSBN. OR will initially carry the Trident II D5LE missile.



Source: © 2012 General Dynamics Electric Boat.

Current Status

The Navy is continuing to develop and evaluate new technologies to incorporate into OR, including an X-stern configuration; a new propulsor; and an extended-life drive shaft that, according to program officials, will increase the platform's availability. According to program officials, the Navy continues to prototype and test the X-stern and propulsor technologies on a scale model to minimize risk. In 2014, the contractor and the Navy completed ship specifications and set the ship's length, both major milestones, as it commits to the space available for ship systems. The program plans to complete 83 percent of the design disclosures—the detailed plans used on the shop floor—prior to the start of construction. In October 2014, the program awarded a contract for production of 17 missile tubes, one of the boat's critical subsystems. According to program officials, these tubes will support the quad pack prototype, testing, and also the United Kingdom's replacement SSBN.

Officials stated that they are continuing to investigate cost saving options including maximizing equipment reuse from Virginia- and Ohio-class submarines and also leveraging manufacturing techniques, such as robotic welding and modular construction. According to program officials, the Navy is also investigating alternate contracting strategies such as a joint-class block buy with Virginia-class submarines or multi-year contracting, which may provide for additional savings by allowing for volume discounts in material purchases. Multi-year contracting is allowed by statute if, among other things, the design is stable, technical risk is not excessive, and the costs estimates are realistic. It is typically not used with lead ship construction because of the unknowns inherent in Navy lead ship construction.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: $95,775.7 million
Research and development: $11,801 million
Procurement: $83,974.7 million
Quantity: 12

Next Major Program Event: Development request for proposal release decision point.

Program Office Comments: In commenting on a draft of this assessment, the Navy provided technical comments, which were incorporated where appropriate.

Presidential Aircraft Recapitalization (PAR)

The Presidential Aircraft Recapitalization (PAR) program plans to replace the current VC-25A fleet with a new fleet of aircraft to support the United States President as Head of State, Chief Executive, and Commander in Chief. PAR aircraft will be a four engine commercial derivative wide-body aircraft, uniquely modified to provide the President of the United States, staff, and guests with safe and reliable air transportation with the equivalent level of security and communications capability available in the White House.

Source: U.S. Air Force.

Current Status

Since fiscal year 2012, the PAR program has conducted analysis related to risk reduction, requirements, sustainment, and technology and manufacturing maturity to inform its acquisition strategy and plans for systems engineering, and test and evaluation. According to program officials, these efforts were focused on acquiring a wide-body, commercial-derivative aircraft and modify it to meet required capabilities with existing technologies. The program plans to seek a waiver from the requirement to conduct competitive prototyping before entering engineering and manufacturing development. Program officials stated they are engaged in ongoing discussions with Air Force and DOD senior leadership regarding the acquisition strategy to ensure the program is in line with "Better Buying Power" initiatives. Also, according to program officials, the Joint Requirements Oversight Council validated the PAR capability development document in November 2014 and endorsed user operational requirements. The Air Force is still determining the number of aircraft needed to replace the current VC-25A fleet. The number of aircraft used to support research, development, test and evaluation will be determined by the acquisition strategy, when approved. Once development is completed, the aircraft will be delivered as a fully capable aircraft to support presidential missions in fiscal year 2023. Additional deliveries are expected to start in fiscal year 2025.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: TBD
Research and development (fiscal years 2010 through 2019): $1,563.8 million
Procurement: TBD
Quantity: TBD

Next Major Program Event: Development Request for Proposal Release Decision, TBD

Program Office Comments: In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated as appropriate.

Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) System

The Navy's UCLASS system is expected to address a gap in persistent sea-based intelligence, surveillance, reconnaissance, and targeting (ISR&T), and provide precision strike capabilities. The system is made up of three key segments: an air segment; a carrier segment; and a control system and connectivity segment.

Source: Jeff Hobrath, Chief, USN (Ret) President, Naval Tees, LLC.

Current Status

GAO reported in September 2013 that, while the Navy planned to manage UCLASS as a technology development program, its acquisition strategy encompassed activities associated with a program in system development. As such, the Navy would develop, produce, and field a system before initiating key oversight mechanisms and reviews that typically govern system development programs. GAO recommended that the Navy hold a formal review to enter system development following the system-level preliminary design review, scheduled for the end of the first quarter of fiscal year 2016. The Navy did not agree with that recommendation, and a formal review has not yet been scheduled.

The Navy considers all four identified critical technologies to be mature, based on demonstrations of an unmanned system from a carrier. Four firm-fixed-price contracts to develop preliminary designs for the unmanned aerial vehicle segment were awarded in August 2013 and completed in May 2014, with the Navy assessing each proposed design for technical maturity and its ability to meet requirements. Congress and DOD have continued to debate UCLASS requirements during 2014, raising the possibility of further specification changes. To the extent that changes are made or proposed designs differ from the preliminary designs, the Navy may need to perform further validation. The release of the request for proposals for the design, fabrication, test, and delivery of the air segment has been repeatedly delayed, and is now expected to occur after a review of all of DOD's ISR&T programs is completed. DOD and program officials have emphasized the need to carefully synchronize UCLASS development and carrier availability for testing to keep the program on schedule. Further delays may affect that synchronization and increase program risk.

Estimated Program Cost and Quantity (fiscal year 2015 dollars):
Total program: TBD
Research and development: $2,783.0 million
Procurement: TBD
Quantity: TBD

Next Major Program Event: Release request for proposals for design, fabrication, test, and delivery of air segment, TBD

Program Office Comments: The Navy provided technical comments, which were incorporated as appropriate.

Agency Comments and Our Evaluation

We are not making recommendations in this report. DOD provided written comments on a draft of this report. The comments are reprinted in appendix VII. We also received technical comments from DOD, which have been addressed in the report as appropriate.

In its comments, DOD noted that it was encouraged by the performance of its major acquisition programs. It also noted that it had released Better Buying Power 3.0 and DOD Instruction 5000.02 and in the summer would publish its third annual report on its analysis of the performance of the defense acquisition system. DOD took issue with our discussion of waivers for full funding of programs within the five year defense spending plan, stating that the waivers were an artifact of the statutory language related to the timing of program decisions and their relation to the budgeting process. It further stated that the requirement for full funding is enforced and that the waivers are cleared when compliance is demonstrated.

Regarding the full funding waivers, we expanded the language in the report to acknowledge that programs, at times, receive this waiver at a point in the budget process when it may be difficult to fully account for their funding needs in a budget request that is in the final stages of development. We also noted that while these waivers are later removed, it can take some time before it is done with it occurring more than 3 years later in one case. Such delays are of concern. We have previously reported on DOD's challenges in fully budgeting for programs when they are initiated and the consequences for both the programs involved and DOD's overall investment strategy.[1]

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

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

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 Rodney Frelinghuysen
Chairman
The Honorable Pete Visclosky
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Scope and Methodology

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

To develop our observations on the overall changes in the size, cost, and cycle time of Department of Defense's portfolio of 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 (DAMIR) Purview system, referred to as DAMIR.[1] We converted all cost information to fiscal year 2015 dollars using conversion factors from the DOD Comptroller's National Defense Budget Estimates for Fiscal Year 2015 (table 5-9). Data for the total planned investment of major defense acquisition programs were obtained from DAMIR, which we aggregated for all programs using fiscal year 2015 dollars. Through discussions with DOD officials responsible for the database and confirming selected data with program offices, we determined that the SAR data and the information retrieved from DAMIR were sufficiently reliable for the purposes of this report. In general, we refer to the 78 major defense acquisition programs with SARs dated December 2013 as DOD's 2014 or current portfolio and use a similar convention for prior year portfolios. We compared the programs that issued SARs in December 2013 with the list of programs that had issued SARs in December 2012 (2013 portfolio) to identify the programs that exited and entered the current portfolio. The Missile Defense Agency's Ballistic Missile Defense System is excluded from all analyses as the program does 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.

To determine the portfolio cost and funding trends since 2004, we collected data from the annual December SARs for the years 2003 (2004 portfolio) through 2013 (2014 portfolio). Typically, our annual assessment includes comparisons of cost, schedule, and performance changes over the past year, 5 years, and from baseline estimates. This year however, we are looking at changes over the past year, 4 years, and from baseline estimates because no annual SARs were released for the December 2008 submission date. As a result the 2009 portfolio is excluded from our assessment. We then analyzed the data to determine the number of programs in each portfolio year as well as the year-by-year totals for research and development, procurement, and other acquisition funding for each portfolio year, as well as the total amount of funding invested or

[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.

remaining and, in specific cases, the amount due to cost growth. To determine the funding already invested and the funding remaining that is needed to complete the programs in each portfolio since 2004, we used funding stream data obtained from DAMIR for each December SAR submission for the years 2003 (2004 portfolio) through 2013 (2014 portfolio). We define funding invested as all funding that has been provided to the programs in the fiscal year of the annual SAR submission (fiscal year 2014 for the December 2013 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 2015 and later for the December 2013 submission).

To determine the cost and schedule changes on defense acquisition programs in the current portfolio over the past year, 4 years, and from baseline estimates, we collected data from December 2013, December 2012, and December 2009 SARs; acquisition program baselines; and program offices. For programs less than a year old, we calculated the difference between the December 2013 SAR current estimate and the first full estimate to identify the cost and schedule change over the past year. For programs less than 4 years old, we took a similar approach when calculating the cost and schedule change over the past 4 years. We retrieved data on research, development, test, and evaluation; procurement; total acquisition cost; and schedule estimates for the 78 programs in the 2014 portfolio.[2] We divided three programs into two distinct elements, because DOD reports performance data on them separately. As a result some of our analysis reflects a total of 81 programs and sub-elements. We analyzed the data to determine the change in research and development, procurement, and total acquisition costs as well as schedule changes from the first full estimate, generally development start, to the current estimate in the December 2013 SAR. For the programs that did not have a development estimate, we compared the current estimate to the production estimate. Also, for the shipbuilding programs that had a planning estimate, we compared the current estimate to the planning estimate. For programs that began as non–major defense acquisition programs, the first full estimate we used as a baseline may differ from the baseline disclosed in the program's initial DOD SAR

[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.

submission. We obtained schedule information and calculated the cycle time from program start to initial operational capability and the delay in obtaining initial operational capability. For programs in the current portfolio where schedule data for initial operational capability was not available over the past year and 4 years due to program age, we used the same methodology as used when calculating cost change for programs that are less than a year old and less than 4 years old.

To determine whether programs experienced an increase or decrease in buying power over the past year and the past 4 years, we obtained data on program acquisition unit cost to determine whether a program's buying power had increased or decreased. Changes in buying power over the past year were found by reviewing 2012 and 2013 SAR data to determine how changes in quantity impacted procurement cost changes. Buying power changes reported in our prior year assessments were reviewed to determine increases or decreases in buying power over the past 4 years. When analyzing buying power changes, we also calculated the amount of procurement cost growth attributable to quantity changes, we isolated the change in procurement quantities and the prior-year's average procurement unit cost for programs over the past year and 4 years. For those programs with a change in procurement quantities, we calculated the amount attributable to quantity changes as the change in quantity multiplied by the average procurement unit cost for the program a year ago. 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. To determine whether any trends in buying power changes occurred over the past 4 years, we conducted the same analysis as discussed above while excluding any programs that were not in each of the portfolios of the past 4 years. We examined 68 major defense acquisition programs for their buying power increases or decreases over the past 4 years.

To evaluate program performance against high-risk criteria discussed by DOD, the Office of Management and Budget (OMB), and GAO, we calculated how many programs had less than a 2 percent increase in total acquisition cost over the past year and less than a 15 percent increase from first full estimates using data from December 2013 and December 2012 SARs; initial acquisition program baselines; and program offices. We could not evaluate program performance against the criteria for a 5-year cost performance comparison, as we would in a typical assessment year, because no December 2008 SARs were issued. For programs that began as non–major defense acquisition programs, the first full estimate we used as a baseline may differ from the baseline provided in the program's initial SAR submission. We also compared the performance of the 2014 portfolio in each high-risk category with the performance of the 2013 through 2011 portfolios we reported on in prior year assessments to identify any positive or negative 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. We also identified programs reporting a significant development cost estimate increase over the past year and determined how many are in production.

Additionally, we used the same analysis described above to determine the cost and schedule changes over the past year for the entire portfolio, to determine the number of programs in production that reported a 2 percent or more increase over the past year in their development cost estimate. We also used this analysis to examine the F-35 Joint Strike Fighter's cost and schedule growth and examined the portfolio's cost and schedule growth when this program is excluded from the totals.

Analysis of Selected DOD Programs Using Knowledge-Based Criteria

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 two electronic questionnaires, one questionnaire for the 38 current programs and a slightly different questionnaire for the 15 future programs. Both of the questionnaires were sent by e-mail in an attached Microsoft Word form that respondents could return electronically. We received responses from August to November 2014 from all of the programs we assessed. To ensure the reliability of the data collected through our questionnaires, we took a number of steps to reduce measurement error and non-response error. These steps included conducting one pretest of the future major defense acquisition program questionnaire and four pretests for the major defense acquisition program questionnaire prior to distribution to ensure that our questions were clear, unbiased, and consistently interpreted; reviewing responses to identify obvious errors or inconsistencies; conducting follow-up to clarify responses when needed; and verifying the accuracy of a sample of keypunched questionnaires. Our pretests covered each branch of the military to better ensure that the questionnaires could be understood by officials within each branch. We determined that the data were sufficiently reliable for the purposes of this report.

Our analysis of how well programs are adhering to a knowledge-based acquisition approach focuses on 38 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. In particular, we focused on the seven programs that crossed these key acquisition points in 2014 and evaluated their adherence to knowledge-based practices. We also provide some insight into how much knowledge is obtained at key junctures by other programs we assessed as well. We also included observations on the knowledge that 15 future programs expect to obtain before starting development as well as how much knowledge 17 current programs expect to obtain before reaching their production start. 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.

The 53 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. For each decision point, we summarized knowledge attainment for the number of programs with data that had reached that knowledge point. 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 appendix I. See also appendix IV for a list of the practices that are associated with a knowledge-based acquisition approach.

Analysis of Acquisition Initiatives and Program Concurrency

To develop observations on how DOD has begun to implement acquisition reforms, we obtained and analyzed the Interim DOD 5000.02 acquisition instruction, 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.”[3] The Interim DOD 5000.02 acquisition instruction incorporates the policy changes mandated by WSARA and several previously released “Better Buying Power” memoranda. We analyzed questionnaire data received from the 38 current and 15 future major defense acquisition programs in our assessment to determine the extent to which specific acquisition reform issues have been implemented such as establishing affordability constraints, conducting “should-cost” analyses, and planning for competition throughout the acquisition life-cycle.

We also evaluated implementation of two legislative initiatives. First, to determine the extent to which programs are conducting annual configuration steering boards, we used the questionnaire responses from all 38 current programs to determine if one was held in the past year and whether one is planned to be held. We also collected data on whether any requirements changes were approved at the configuration steering boards and assessed whether this resulted in an increase or decrease in capability. Second, to determine how DOD is implementing milestone B certifications and the extent to which waivers are granted, we identified the programs in our assessment that have held a milestone B since the implementation of WSARA in 2009. We used the questionnaire responses from these programs to identify the number of certifications made and waivers granted at milestone B by these programs.

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 and the metrics programs reported using to manage their software development. We also 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.

[3]Interim Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System* (Nov. 25 2013). A finalized version of this instruction was released in January 2015, after our audit cutoff date. Pub. L. No. 111-23.

To assess program 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.

Individual Assessments of Weapon Programs

In total, this report presents individual assessments of 53 weapon programs. A table listing these programs is found in appendix VIII. Out of these programs, 37 are captured in a two-page format discussing technology, design, and manufacturing knowledge obtained and other program issues. Thirty-five of these 37 two-page assessments are of major defense acquisition programs, most of which are in development or early production, and two assessments are of programs that were projected to become major defense acquisition programs during or soon after our review. The remaining 16 programs are described in a one-page format that describes their current status. Those one-page assessments include 15 future major defense acquisition programs and one major defense acquisition program that is well into production. 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 the 53 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. 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. 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 detailed 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 2014 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 2015 dollars. We converted cost information to fiscal year 2015 dollars using conversion factors from the DOD Comptroller's National Defense Budget Estimates for Fiscal Year 2015 (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. 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 2015 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.

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 32 of the major defense acquisition programs included in our assessment using the contract information reported in their December 2013 Selected Acquisition Reports. See appendix VI for a list of the programs we reviewed. The contract numbers for each program's prime contracts were entered into the eSRS database to determine whether the individual subcontracting reports had been accepted by the government. While we did not assess the reliability of the eSRS database, we took steps to ensure that the data provided by the database was sufficiently reliable for the purpose of our analysis by interviewing defense officials with knowledge of DOD's process for eSRS and collecting data from program offices on contract reporting. 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 this data is not captured in the individual subcontracting reports.

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.

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 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 an operational environment—is the level of technology maturity that constitutes a low risk for starting a product development program.[4] For shipbuilding programs, we have recommended that this level of maturity be achieved by the contract award for detailed design.[5] 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 demonstrated in 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,

[4]GAO, *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, GAO/NSIAD-99-162 (Washington, D.C.: July 30, 1999); and 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).

[5]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).

we asked program officials to provide the date of the 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" 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 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 manufacturing readiness levels (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 June 2014 to March 2015, 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.

Current and First Full Estimates for DOD's 2014 Portfolio of Major Defense Acquisition Programs

Table 7 contains the current and first full total acquisition cost estimates (in fiscal year 2015 dollars) for each program or element in the Department of Defense's (DOD) 2014 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 4 years.

Table 7: Current Cost Estimates and First Full Estimates for DOD's 2014 Portfolio of Major Defense Acquisition Programs

Fiscal year 2015 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 4 years (percent)
Advanced Extremely High Frequency Satellite (AEHF)	$14,474	$6,747	114.5%	-1.3%	4.2%
AGM-88E Advanced Anti-Radiation Guided Missile (AGM-88E AARGM)	$2,249	$1,696	32.6%	8.3%	14.6%
AH-64E Apache New Build (AH-64E New Build)	$2,280	$2,510	-9.2%	6.8%	-9.2%
AH-64E Apache Remanufacture (AH-64E Remanufacture)	$13,894	$7,671	81.1%	10.4%	22.2%
AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM)	$24,548	$11,575	112.1%	1.3%	-4.5%
AIM-9X Block II Air-to-Air Missile	$3,623	$4,231	-14.4%	-5.1%	-14.4%
Air and Missile Defense Radar (AMDR)	$5,193	$5,920	-12.3%	-12.3%	-12.3%
Airborne & Maritime/Fixed Station Joint Tactical Radio System (AMF JTRS)	$3,473	$8,636	-59.8%	-3.7%	-60.7%
Airborne Warning and Control System Block 40/45 Upgrade (AWACS Blk 40/45 Upgrade)	$2,803	$2,957	-5.2%	-2.8%	-5.2%
B-2 Extremely High Frequency SATCOM and Computer Increment 1 (B-2 EHF Inc1)	$578	$752	-23.1%	-3.4%	-13.1%
B61 Mod 12 Life Extension Program Tailkit Assembly (B61 Mod 12 LEP TKA)	$1,381	$1,385	-0.3%	0.2%	-0.3%
C-130J Hercules Transport Aircraft	$16,746	$1,005	1566.1%	1.1%	1.6%
C-5 Reliability Enhancement and Re-engining Program (C-5 RERP)	$7,494	$11,550	-35.1%	-2.9%	-5.1%
CH-47F Improved Cargo Helicopter	$15,788	$3,410	363.0%	4.5%	8.5%
CH-53K Heavy Lift Replacement Helicopter	$25,335	$17,536	44.5%	1.4%	7.6%
Chemical Demilitarization-Assembled Chemical Weapons Alternatives (Chem Demil-ACWA)	$10,888	$2,799	289.1%	3.0%	27.5%
Cooperative Engagement Capability (CEC)	$5,578	$3,118	78.9%	0.9%	2.5%
DDG 1000 Zumwalt Class Destroyer	$22,497	$36,858	-39.0%	1.5%	5.6%

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Fiscal year 2015 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 4 years (percent)
DDG 51 Arleigh Burke Class Guided Missile Destroyer	$110,550	$16,087	587.2%	1.8%	9.0%
E-2D Advanced Hawkeye Aircraft (E-2D AHE)	$21,027	$15,625	34.6%	4.9%	9.7%
EA-18G Growler Aircraft (EA-18G)	$13,598	$9,507	43.0%	-1.3%	9.0%
Evolved Expendable Launch Vehicle (EELV)	$61,364	$18,404	233.4%	-4.7%	69.9%
Excalibur Precision 155mm Projectiles (Excalibur)	$1,931	$5,059	-61.8%	1.9%	-26.3%
F-22 Increment 3.2B Modernization (F-22 Inc 3.2B Mod)	$1,565	$1,587	-1.4%	-1.4%	-1.4%
F-35 Joint Strike Fighter Aircraft	$338,950	$226,355	49.7%	1.3%	11.1%
Family of Beyond Line-of-Sight - Terminals (FAB-T)	$4,758	$3,377	40.9%	2.3%	12.6%
Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)	$36,296	$37,680	-3.7%	0.1%	-1.2%
Global Broadcast Service (GBS)	$1,247	$610	104.4%	-3.0%	3.6%
Global Positioning System III (GPS III)	$4,645	$4,175	11.3%	5.4%	4.3%
Ground/Air Task Oriented Radar (G/ATOR)	$2,740	$1,553	76.5%	18.4%	76.5%
Guided Multiple Launch Rocket System/Guided Multiple Launch Rocket System Alternative Warhead (GMLRS/GMLRS AW)	$6,920	$1,873	269.5%	5.4%	11.6%
H-1 Upgrades (4BW/4BN) (H-1 Upgrades)	$13,349	$3,841	247.5%	2.5%	4.6%
HC/MC-130 Recapitalization Aircraft (HC/MC-130 Recap)	$14,342	$8,859	61.9%	3.3%	61.9%
Integrated Air and Missile Defense (IAMD)	$6,239	$5,326	17.2%	6.8%	17.2%
Integrated Defensive Electronic Countermeasures (IDECM)	$2,633	$2,306	14.2%	1.3%	10.1%
IDECM Blocks 2/3	$1,735	$1,570	10.5%	0.2%	5.4%
IDECM Block 4	$898	$735	22.1%	3.4%	20.6%
Joint Air-to-Surface Standoff Missile (JASSM) and JASSM-Extended Range (JASSM-ER)	$7,198	$2,455	193.2%	-1.1%	-7.1%
Joint Direct Attack Munition (JDAM)	$8,228	$3,621	127.2%	9.7%	20.0%
Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS)	$2,756	$7,060	-61.0%	-1.6%	-65.3%
Joint Light Tactical Vehicle (JLTV)	$23,728	$23,869	-0.6%	-0.4%	-0.6%
Joint Precision Approach and Landing System Increment 1A (JPALS Inc 1A)	$1,598	$1,072	49.1%	41.2%	53.0%
Joint Standoff Weapon - Baseline Variant and Unitary Warhead Variant (JSOW)	$5,873	$8,418	-30.2%	1.6%	2.4%
JSOW - Baseline Variant	$2,361	$3,026	-22.0%	-0.4%	-0.5%
JSOW - Unitary Warhead Variant	$3,512	$5,392	-34.9%	3.0%	4.5%
Joint Tactical Networks (JTN)	$2,293	$1,039	120.7%	0.7%	6.9%

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Fiscal year 2015 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 4 years (percent)
Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios (JTRS HMS)	$10,363	$10,632	-2.5%	15.2%	101.4%
KC-130J Transport Aircraft	$10,221	$10,046	1.7%	3.1%	1.7%
KC-46 Tanker Modernization Program	$43,159	$46,414	-7.0%	-3.7%	-7.0%
LHA 6 AMERICA CLASS Amphibious Assault Ship	$10,094	$3,368	199.7%	-0.8%	47.0%
Littoral Combat Ship (LCS)	$21,335	$2,377	NA	-29.4%	NA
Littoral Combat Ship - Mission Packages (LCS MP)	$6,707	$6,940	-3.4%	-3.4%	-3.4%
LPD 17 San Antonio Class Amphibious Transport Dock	$19,783	$12,405	59.5%	1.1%	0.2%
M109A7 Family of Vehicles (M109A7 FOV)	$7,083	$7,083	0.0%	1.5%	0.0%
MH-60R Multi-Mission Helicopter	$13,659	$5,863	133.0%	-5.5%	-11.4%
MH-60S Fleet Combat Support Helicopter	$8,684	$3,716	133.7%	-1.2%	-2.9%
Mobile User Objective System (MUOS)	$7,606	$7,119	6.8%	1.4%	3.6%
MQ-1C Gray Eagle Unmanned Aircraft System	$4,823	$1,075	348.5%	-3.3%	-10.0%
MQ-4C Triton Unmanned Aircraft System	$13,627	$13,607	0.2%	-0.1%	-2.7%
MQ-8 Fire Scout	$3,061	$2,770	10.5%	8.1%	15.3%
MQ-9 Reaper Unmanned Aircraft System	$11,559	$2,793	313.8%	-9.7%	-3.4%
Multifunctional Information Distribution System (MIDS)	$3,937	$1,381	185.1%	2.7%	24.6%
National Airspace System (NAS)	$1,696	$920	84.4%	0.8%	-1.3%
Navy Multiband Terminal (NMT)	$1,970	$2,458	-19.9%	1.0%	-8.6%
Next Generation Operational Control System (GPS OCX)	$3,501	$3,507	-0.2%	0.2%	-0.2%
P-8A Poseidon Multi-Mission Maritime Aircraft	$32,996	$32,871	0.4%	-4.6%	-5.2%
Patriot Advanced Capability-3 (PAC-3)	$13,564	$5,521	145.7%	2.4%	17.2%
Patriot/Medium Extended Air Defense System Combined Aggregate Program (Patriot/MEADS CAP)	$11,562	$28,228	-59.0%	-2.2%	-58.9%
Patriot/MEADS CAP Fire Unit	$3,361	$20,509	-83.6%	-1.4%	-83.1%
Patriot/MEADS CAP Missile	$8,202	$7,718	6.3%	-2.6%	-0.6%
Remote Minehunting System (RMS)	$1,520	$1,527	-0.5%	3.2%	10.9%
RQ-4A/B Global Hawk Unmanned Aircraft System	$10,037	$5,711	75.7%	0.9%	-31.2%
Ship to Shore Connector Amphibious Craft (SSC)	$4,054	$4,187	-3.2%	-0.7%	-3.2%
Small Diameter Bomb Increment II (SDB II)	$3,898	$4,980	-21.7%	0.8%	-21.7%
Space Based Infrared System High (SBIRS High)	$18,684	$4,869	283.8%	-2.8%	8.9%
SSN 774 Virginia Class Submarine	$85,328	$64,028	33.3%	0.5%	-3.4%

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Fiscal year 2015 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 4 years (percent)
Standard Missile-6 (SM-6)	$9,207	$6,038	52.5%	2.2%	39.6%
Tactical Tomahawk RGM-109E/UGM-109E Missile (TACTOM)	$5,852	$2,241	161.1%	-22.0%	-20.5%
Trident II (D-5) Sea-Launched Ballistic Missile UGM 133A (Trident II Missile)	$57,011	$54,787	4.1%	0.3%	3.1%
UH-60M Black Hawk Helicopter	$25,338	$13,737	84.4%	3.3%	7.4%
V-22 Osprey Joint Services Advanced Vertical Lift Aircraft	$60,981	$42,476	43.6%	-0.2%	1.2%
Warfighter Information Network-Tactical Increment 2 (WIN-T Inc 2)	$12,523	$3,928	218.8%	146.4%	145.6%
Warfighter Information Network-Tactical Increment 3 (WIN-T Inc 3)	$3,647	$17,335	-79.0%	-76.5%	-75.0%
Wideband Global SATCOM (WGS)	$4,101	$1,264	224.4%	-2.0%	7.1%

Source: GAO analysis of DOD data. | GAO-15-342SP

Notes: Data were obtained from DOD's Selected Acquisition Reports, acquisition program baselines, and, in some cases, program offices. Changes in total acquisition cost for the Littoral Combat Ship over the past 4 years and from its first full estimate are shown as "NA" because DOD reported an incomplete baseline and cost data for the program through 2010.

Changes in DOD's 2014 Portfolio of Major Defense Acquisition Programs over 4 Years and Since First Full Estimates

Table 8 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 Department of Defense's (DOD) 2014 portfolio over the last 4 years and since their first full cost and schedule estimates.

Table 8: Cost and Schedule Changes for Programs in DOD's 2014 Portfolio

Fiscal year 2015 dollars (in billions)

	4 year comparison (2009-2014)	Since first full estimate (Baseline to 2014)
Change in total research and development cost	$17.4 billion 6.5%	$98.5 billion 52.8%
Change in total procurement cost	$57.3 billion 5.3%	$357.8 billion 45.8%
Change in total other acquisition costs	$2.2 billion 21.7%	$1.2 billion 10.4%
Change in total acquisition cost[a]	$76.9 billion 5.7%	$457.5 billion 46.8%
Average delay in delivering initial capabilities	7.0 months 8.5%	28.9 months 36.5%

Source: GAO analysis of DOD data. | GAO-15-342SP

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

Knowledge-Based Acquisition Practices

GAO's prior work on best product-development practices found that successful programs take steps to gather knowledge that confirms 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 9: 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-15-342SP

[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.

Technology Readiness Levels

	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 nonscale 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 nonscale 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.
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.

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	Technology readiness level	Description	Hardware/software	Demonstration environment
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-15-342SP

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 accepted during 2014 in the Electronic Subcontracting Reporting System (eSRS). We reviewed this information for 32 of the major defense acquisition programs included in our assessment that reported prime contracts in their December 2013 Selected Acquisition Report (SAR) submissions. The government uses individual subcontracting reports from eSRS as one method of monitoring small business participation, as this report includes information on contractors' performance against small business subcontracting goals. There are multiple reasons why a prime contractor may not have an accepted subcontracting report in eSRS.

For example, some contractors may have pending or rejected reports within the system as all reports are reviewed prior to acceptance. Not all prime contracts for major defense acquisition programs are required to submit individual subcontracting reports. Instead, 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 prime contractor may be required to submit a report, it may not yet have done so for the period we reviewed.[2]

[1]As of October 2014, 11 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). One additional company ceased participation in 2007, although active contracts awarded before that time are still reported through the test program. 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 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.

[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.: December 11, 2014).

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

Program name	Number of contracts listed in the December 2013 SAR	Contracts with an accepted individual subcontracting report (as of January 2015)
AIM-9X Block II Air-to-Air Missile	3	0
Air and Missile Defense Radar (AMDR)	1	0
Airborne and Maritime/Fixed Station Joint Tactical Radio System (AMF JTRS)	0	0
CH-53K Heavy Lift Replacement Helicopter	1	0
Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)	5	2
DDG 1000 Zumwalt Class Destroyer	4	4
DDG 51 Arleigh Burke Class Guided Missile Destroyer	6	5
Evolved Expendable Launch Vehicle (EELV)	6	3
Excalibur Precision 155mm Projectiles (Excalibur)	2	0
F-22 Increment 3.2B (F-22 Inc 3.2B)	2	0
F-35 Joint Strike Fighter Aircraft	6	0
Family of Beyond Line-of-Sight Terminals (FAB-T)	2	0
Global Positioning System III (GPS III)	2	0
Ground/Air Task Oriented Radar (G/ATOR)	0	0
Integrated Air and Missile Defense (IAMD)	2	1
Joint Air-to-Surface Standoff Missile-Extended Range (JASSM-ER)	4	0
Joint Light Tactical Vehicle (JLTV)	3	2
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)	1	0
KC-46 Tanker Modernization Program	2	2
LHA 6 America Class Amphibious Assault Ship	1	1
Littoral Combat Ship (LCS)	3	2
Littoral Combat Ship – Mission Packages (LCS MP)	1	0
M109A7 Family of Vehicles (M109A7 FOV)	2	2
Mobile User Objective System (MUOS)	1	0
MQ-4C Triton Unmanned Aircraft System	1	1
MQ-8 Fire Scout	1	1
Next Generation Operational Control System (GPS OCX)	1	0
Ship to Shore Connector (SSC)	1	1
Small Diameter Bomb Increment II (SDB II)	1	0
Warfighter Information Network-Tactical Increment 2 (WIN-T Inc 2)	1	0

(Continued From Previous Page)

Program name	Number of contracts listed in the December 2013 SAR	Contracts with an accepted individual subcontracting report (as of January 2015)
Warfighter Information Network-Tactical Increment 3 (WIN-T Inc 3)	1	0
Totals	**68**	**27**

Source: GAO analysis of data from DOD and eSRS. | GAO-15-342SP

Comments from the Department of Defense

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

ACQUISITION, TECHNOLOGY AND LOGISTICS

MAR 4 2015

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-15-342SP, "Defense Acquisitions: Assessments of Selected Weapon Programs" dated March 2015 (GAO Code 121215).

The Department is pleased that this year's Draft Report, the 13th annual assessment on the performance of DoD's major acquisition programs, is once again very encouraging and indicates cost controlling efforts are working. GAO data shows the estimated total cost of the Major Defense Acquisition Program portfolio decreased by $90 billion from last year's Report, making it the lowest total portfolio cost in over a decade. In addition, the year-to-year cost growth across all 78 programs decreased by more than $7 billion.

We would like to note that the discussion in Section 3 on full funding waivers is misleading. GAO claims that seven programs received waivers associated with the requirement to certify that funding is available to execute product development and production as planned. These waivers are an artifact of the statutory language related to the timing of the decision and the FYDP in place at that time. The USD(AT&L) directs full funding in the Acquisition Decision Memorandum and enforces full funding in the budget process. The USD(AT&L) "clears" these waivers when full funding is demonstrated. There is no cost growth due strictly to this practice, as GAO claims.

The USD(AT&L) released Better Buying Power 3.0 and a new DoD Instruction 5000.02 to continue improving our ability to provide affordable, value-added military capability to the Warfighter. In addition, the USD(AT&L) will publish the third annual comprehensive report on the performance of the Defense acquisition system in the Summer of 2015. The publically available report will again be a data driven analysis that provides transparent and objective performance measures of our major acquisition programs and contracts.

The Department appreciates the opportunity to comment on the Draft Report. My point of contact for this effort is Mr. Joe Beauregard, 703-614-5420.

Sincerely,

Nancy L. Spruill

Nancy L. Spruill
Director
Acquisition Resources & Analysis

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GAO Contact and Staff Acknowledgments

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Staff Acknowledgments

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The following primary staff were responsible for individual programs:

Program name	Primary staff
Current programs	
AIM-9X Block II Air-to-Air Missile	Jennifer A. Dougherty, Ramzi N. Nemo
Air and Missile Defense Radar (AMDR)	C. James Madar, Joe Franzwa, Gwyneth B. Woolwine
Airborne & Maritime/Fixed Station Joint Tactical Radio System (AMF JTRS)	Lindsay C. Taylor, Nathan A. Tranquilli
Armored Multi-Purpose Vehicle (AMPV)	Andrea M. Bivens, Marcus C. Ferguson
CH-53K Heavy Lift Replacement Helicopter	Robert K. Miller, Brian T. Smith
Combat Rescue Helicopter (CRH)	Laura M. Jezewski, J. Andrew Walker
DDG 1000 Zumwalt Class Destroyer	Angie Nichols-Friedman, Christopher E. Kunitz
DDG 51 Arleigh Burke Class Guided Missile Destroyer	Christopher R. Durbin, C. James Madar
Evolved Expendable Launch Vehicle (EELV)	Desirée E. Cunningham, Erin R. Cohen, Breanna M. Trexler
Enhanced Polar System (EPS)	Bradley L. Terry, Maricela Cherveny
Excalibur Precision 155mm Projectiles	Ryan Stott, James P. Haynes
F-22 Increment 3.2B	Julie C. Hadley, Robert P. Bullock, Sean C. Seales
F-35 Lightning II	Megan L. Porter, Abby C. Volk
Family of Advanced Beyond Line-of-Sight Terminals (FAB-T)	Alexandra Dew Silva, Scott M. Purdy
Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)	Burns C. Eckert, Scott Bruckner
Global Positioning System III (GPS III)	Laura T. Holliday, Raj C. Chitikila
Ground/Air Task Oriented Radar (G/ATOR)	Erin E. Preston, Sean E. Manzano
Integrated Air and Missile Defense (IAMD)	Maria A. Durant, John M. Ortiz
Joint Air-to-Surface Standoff Missile Extended Range (JASSM-ER)	Brian A. Tittle, John W. Crawford
Joint Light Tactical Vehicle (JLTV)	Marcus C. Ferguson, Betsy Gregory-Hosler
Joint Precision Approach and Landing System Increment 1A (JPALS Inc 1A)	Stephen V. Marchesani, Jared A. Sippel

(Continued From Previous Page)

Program name	Primary staff
Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios (JTRS HMS)	Nathan A. Tranquilli, Lindsay C. Taylor
KC-46 Tanker Modernization Program	Jeffrey L. Hartnett, Katheryn S. Hubbell
LHA 6 America Class Amphibious Assault Ship	Christopher E. Kunitz
Littoral Combat Ship (LCS)	Heather B. Miller, Burns C. Eckert
Littoral Combat Ship - Mission Packages (LCS MP)	Laurier R. Fish, John M. Rastler
Military GPS User Equipment (MGUE), Increment 1	Raj Chitikila, Tana Davis
Mobile User Objective System (MUOS)	Brenna E. Guarneros, Bradley L. Terry
MQ-4C Triton Unmanned Aircraft System	Matthew Shaffer, Tom Twambly
MQ-8 Fire Scout	Leigh Ann Haydon, James Kim
Next Generation Operational Control System (GPS OCX)	Erin R. Cohen, Claire A. Buck
M109A7 Family of Vehicles (M109A7 FOV)	William C. Allbritton, Richard Cederholm
VH-92A Presidential Helicopter Replacement	Bonita J. P. Oden, William C. Allbritton
Ship to Shore Connector (SSC)	Teague A. Lyons, Matthew Shaffer
Small Diameter Bomb Increment II (SDB II)	John W. Crawford, Brian A. Tittle
Space Fence	Laura D. Hook, Suzanne Sterling
Three-Dimensional Expeditionary Long-Range Radar (3DELRR)	Claire Li, Anne McDonough-Hughes
Warfighter Information Network-Tactical Increment 2 (WIN-T Inc 2)	James P. Tallon, Anh L. Nguyen
Warfighter Information Network-Tactical Increment 3 (WIN-T Inc 3)	Anh L. Nguyen, James P. Tallon
Future Programs	
Amphibious Combat Vehicle (ACV)	Scott M. Purdy, Betsy Gregory-Hosler, MacKenzie H. Cooper, David Richards
B-2 Defensive Management System (DMS) Modernization	Matthew B. Lea, Don M. Springman
Common Infrared Countermeasure (CIRCM)	Danny G. Owens, Carol T. Mebane
F-15 Eagle Passive/Active Warning and Survivability System (F-15 EPAWSS)	Wendell K. Hudson, LeAnna M. Parkey
Fleet Replenishment Oiler (T-AO(X))	Dina Shorafa, Christopher R. Durbin,
Indirect Fire Protection Capability, Increment 2 (IFPC Inc 2)	Helena Brink, James P. Haynes
Improved Turbine Engine (ITE)	Jessica Berkholz, Wendy P. Smythe
Joint Air-to-Ground Missile (JAGM)	Daniel Singleton, Wendy P. Smythe
Joint Surveillance Target Attack Radar System (JSTARS)	J. Andrew Walker, Sameena Nooruddin Ismailjee
Next Generation Jammer (NGJ)	Teakoe S. Coleman, Laura T. Holliday
Offensive Anti-Surface Warfare (OASuW)	Tom Twambly, Jocelyn C. Yin
Ohio-class Replacement (OR)	C. James Madar, Brandon H. Greene
Presidential Aircraft Recapitalization (PAR)	LeAnna M. Parkey, Wendell K. Hudson
Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) System	Robert P. Bullock, Julie C. Hadley

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