United States Government Accountability Office

GAO

Report to Congressional Committees

March 2012

DEFENSE ACQUISITIONS

Assessments of Selected Weapon Programs

GAO

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GAO-12-400SP

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Highlights

Highlights of GAO-12-400SP, a report to congressional committees

Why GAO Did This Study

This is GAO's annual assessment of DOD weapon system acquisitions, an area that is on GAO's high-risk list. The report is in response to the mandate in the joint explanatory statement to the DOD Appropriations Act, 2009. It includes (1) observations on the cost performance of DOD's 2011 portfolio of 96 major defense acquisition programs; (2) an assessment of the knowledge attained by key junctures in the acquisition process for 37 major defense acquisition programs, which were selected because they were in development or early production; (3) observations on the implementation of acquisition reforms, particularly for 16 future major defense acquisition programs that are not yet in the portfolio, which represent the best opportunity to assess DOD's progress in this area. To conduct this review, GAO analyzed cost, schedule, and quantity data from DOD's Selected Acquisition Reports and collected data from program offices on technology, design, and manufacturing knowledge; the use of knowledge-based acquisition practices; and the implementation of DOD's acquisition policy and acquisition reforms. GAO also compiled individual assessments of 68 weapon programs. Selection factors include major defense acquisition programs in development or early production, future programs, and recently cancelled programs.

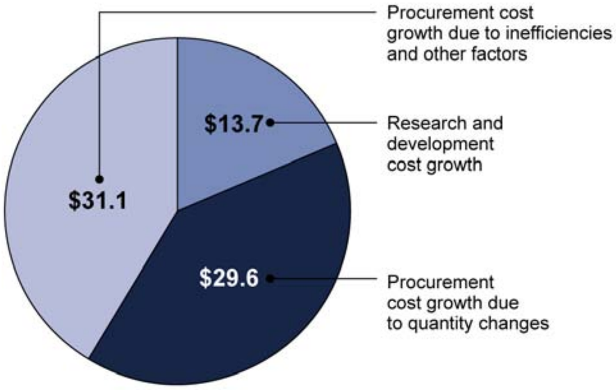
DOD agreed that cost growth has occurred, but did not fully agree with our metrics for measuring cost growth, stating that they did not adequately address when, why, and how it occurred. GAO believes the report directly addresses these distinctions.

View GAO-12-400SP. For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov.

What GAO Found

The total estimated cost of the Department of Defense's (DOD) 2011 portfolio of 96 major defense acquisition programs stands at $1.58 trillion. In the past year, the total acquisition cost of these programs has grown by over $74.4 billion or 5 percent, of which about $31.1 billion can be attributed to factors such as inefficiencies in production, $29.6 billion to quantity changes, and $13.7 billion to research and development cost growth. DOD's portfolio is dominated by a small number of programs, with the Joint Strike Fighter accounting for the most cost growth in the last year, and the largest projected future funding needs. The majority of the programs in the portfolio have lost buying power in the last year as their program acquisition unit costs have increased. The number of programs in the portfolio has decreased from 98 to 96 in the past year and, looking forward, is projected to decrease again next fiscal year to its lowest level since 2004.

Cost Growth over the Past Year for DOD's 2011 Portfolio of Major Defense Acquisition Programs (Fiscal Year 2012 Dollars in Billions)



Source: GAO analysis of DOD data.

In the past 3 years, GAO has reported that newer programs are demonstrating higher levels of knowledge at key decision points. However, most of the 37 programs GAO assessed this year are still not fully adhering to a knowledge-based acquisition approach. Of the eight programs from this group that passed through one of three key decision points in the acquisition process in the past year, only one—Excalibur Increment Ib—implemented all of the applicable knowledge-based practices. As a result, most of these programs will carry technology, design, and production risks into subsequent phases of the acquisition process that could result in cost growth or schedule delays.

GAO also assessed the implementation of selected acquisition reforms and found that most of the 16 future programs we assessed have implemented key provisions of the Weapon Systems Acquisition Reform Act of 2009. Programs have also started to implement new DOD initiatives, such as developing affordability targets and conducting "should cost" analysis. Finally, as could be expected from the increased activity early in the acquisition cycle, the 16 future programs we assessed are planning to spend more funds in technology development than current major defense acquisition programs.

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Abbreviations

BMDS	Ballistic Missile Defense System
CAPE	Cost Assessment and Program Evaluation
DAMIR	Defense Acquisition Management Information Retrieval
DOD	Department of Defense
MDA	Missile Defense Agency
MDAP	major defense acquisition program
MRL	manufacturing readiness level
NA	not applicable
OMB	Office of Management and Budget
RDT&E	research, development, test, and evaluation
SAR	Selected Acquisition Report
TBD	to be determined
TRL	Technology Readiness Level

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**Comptroller General
of the United States**

**United States Government Accountability Office
Washington, D.C. 20548**

March 29, 2012

Congressional Committees

I am pleased to present GAO's annual assessment of selected weapon programs. This report provides a snapshot of how well the Department of Defense (DOD) is planning and executing its major defense acquisition programs—an item on GAO's high-risk list and an area that we have identified as having the potential for significant cost savings in our first two reports on *Opportunities to Reduce Potential Duplication in Government Programs, Save Tax Dollars, and Enhance Revenue*.[1] This year's report offers observations on the performance of DOD's $1.58 trillion portfolio of 96 major defense acquisition programs. These observations serve as measures of DOD's progress in managing weapon system cost growth and as indicators of potential challenges. This year's report also includes assessments of the risks on 68 individual weapon programs. These assessments can assist DOD and Congress in making decisions about the programs they approve and fund in a budget-constrained environment. When we issued our first annual assessment in 2003, it included 26 defense programs ranging from the Marine Corps' Advanced Amphibious Assault Vehicle to the Missile Defense Agency's Theater High Altitude Area Defense system. This edition still includes eight programs that appeared in the 2003 report, which is indicative of the lengthy development times and acquisition challenges that DOD has faced over the last 10 years.

Since we began issuing this report, Congress and DOD have made noteworthy improvements in the legal and policy frameworks that govern weapon system acquisitions by mandating and encouraging a more knowledge-based approach to the development and production of major systems. These changes have led to some improvement in the knowledge attained by programs at key points in the acquisition process, but more still needs to be done. Practice has lagged behind policy in certain areas and we have not yet seen improvements in outcomes that are commensurate with the improvements in law and policy. In our review this year, we found

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[1] GAO, *High Risk Series: An Update*, GAO-11-278 (Washington, D.C.: Feb. 16, 2011); GAO, *Opportunities to Reduce Potential Duplication in Government Programs, Save Tax Dollars, and Enhance Revenue*, GAO-11-318SP (Washington, D.C.: Mar. 1, 2011); GAO, *Follow-up on 2011 Report: Status of Actions Taken to Reduce Duplication, Overlap, and Fragmentation, Save Tax Dollars, and Enhance Revenue*, GAO-12-453SP (Washington, D.C.: Feb. 28, 2012).

that the cost to develop and produce DOD's current portfolio of major defense acquisition programs grew by over $74.4 billion, of which about $31.1 billion can be attributed to factors such as inefficiencies in production, $29.6 billion to quantity changes, and $13.7 billion to research and development cost growth. The implementation of knowledge-based acquisition practices that might prevent or mitigate the potential for cost growth has been uneven across the portfolio. For eight programs that passed through one of three key decision points in the acquisition process this year, only one implemented all of the applicable knowledge-based practices. As a result, most of these programs will carry technology, design, and production risks into subsequent phases of the acquisition process that could result in cost growth or schedule delays.

There have been some positive developments, especially with regard to DOD's future major defense acquisition programs, which are now approaching system development or will bypass system development for production. We found that most of these future programs are implementing acquisition reforms, such as competitive prototyping, early systems engineering reviews, and acquisition strategies ensuring competition or the option of competition, which have the potential to reduce risk and improve outcomes. Some of these activities require higher upfront investments in systems engineering and other areas to reduce longer term development risk, and it will be important for decision makers to sustain these investments when appropriate, even as DOD's budgetary resources shrink.

Gene L. Dodaro

Gene L. Dodaro
Comptroller General of the United States

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Washington, D.C. 20548

March 29, 2012

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This is GAO's annual assessment of selected Department of Defense (DOD) weapon system acquisitions, an area that is on GAO's high-risk list. The report is in response to the mandate in the joint explanatory statement to the DOD Appropriations Act, 2009, which requires us to perform an annual assessment.[1] This report provides a snapshot of how well DOD is planning and executing its weapon programs. Congress and DOD have long explored ways to improve the acquisition of major weapon systems, yet programs are still incurring billions of dollars in cost growth. Given the prospect of decreased defense spending, including the possibility of over $1 trillion in sequestration and other budget cuts over the next 10 years, finding ways to prevent or mitigate cost growth is crucial to our national security. In the past 3 years, we have reported improvements in the knowledge that programs attained about technologies, design, and manufacturing processes at key points during the acquisition process. DOD policy and legislation emphasize key knowledge-based acquisition practices; however, we have found that most programs continue to proceed with less knowledge than recommended, putting them at higher risk for cost growth and schedule delays.

This report includes (1) observations on the cost and schedule performance of DOD's 2011 portfolio of 96 major defense acquisition programs, (2) our assessment of the knowledge attained at key junctures in the acquisition process for 37 weapon programs in development or early production, and (3) observations on the extent to which DOD is

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

implementing acquisition reforms, particularly for 16 future major defense acquisition programs.[2]

There are three sets of programs on which our observations are based in this report:

- We assessed all 96 major defense acquisition programs in DOD's 2011 portfolio for our analysis of cost and schedule performance. To develop our observations, we obtained cost, schedule, and quantity data from DOD's December 2010 Selected Acquisition Reports (SAR) and from the Defense Acquisition Management Information Retrieval Purview system. The Ballistic Missile Defense System (BMDS) is excluded from these observations because comparable cost and quantity data are not available.

- We assessed 37 major defense acquisition programs that were mostly between the start of development and the early stages of production for our analysis of knowledge attained at key junctures and the implementation of acquisition reforms. To develop our observations, we obtained information on the extent to which the programs follow knowledge-based practices for technology maturity, design stability, and production maturity using a data-collection instrument. We also submitted a survey to program offices to collect information on systems engineering reviews, design stability, manufacturing planning and execution, and the implementation of specific acquisition reforms. We received survey responses from all 37 programs.

- We assessed an additional 16 future major defense acquisition programs that we selected because they were preparing to enter system development or production. These programs represent the best opportunity to assess DOD's progress in implementing selected acquisition reforms. To develop our observations, we submitted a survey to program offices to collect information on the implementation

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[2] Major defense acquisition programs are those identified by DOD that require eventual total research, development, test, and evaluation (RDT&E) expenditures, including all planned increments, of more than $365 million, or procurement expenditures, including all planned increments, of more than $2.19 billion, in fiscal year 2000 constant dollars. DOD has a list of programs designated as pre–major defense acquisition programs (pre-MDAP). 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.

of these reforms and other data and received responses from all the programs.

In addition to our observations, we present individual assessments of 68 weapon programs. Selection factors include major defense acquisition programs in development or early production, future programs, and recently cancelled programs.

We conducted this performance audit from August 2011 to March 2012 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. Appendix I contains detailed information on our scope and methodology.

Observations on the Cost Performance of DOD's 2011 Major Defense Acquisition Program Portfolio

The cost of DOD's 2011 portfolio of major defense acquisition programs continues to grow, and the delays in delivering capability to the warfighter have gotten longer. Our analysis of the 96 programs in DOD's 2011 portfolio of major defense acquisition programs allows us to make nine observations.

Cost Performance Observations

1. The estimated cost of DOD's 2011 portfolio stands at about $1.58 trillion and has grown by over $74 billion or 5 percent in the past year.[a]
2. About $30 billion of this growth can be attributed to quantity changes within major defense acquisition programs; the other $45 billion is due to research and development cost growth and production inefficiencies.[b]
3. Many of the programs in the portfolio with the greatest growth in estimated research and development costs in the last year are already in production and either experienced growth because of lingering development issues or added funding for upgrades or modernization efforts.
4. The cost of the portfolio is driven by the 10 highest-cost programs, which account for 55 percent of its total cost.
5. The Joint Strike Fighter accounts for 21 percent of the total cost of the portfolio and 52 percent, or about $39 billion, of the cost growth in the past year.
6. Ninety-one percent of the funding needed to complete the programs in the portfolio is for procurement, with most of that for a few large programs.
7. Over 60 percent of programs have lost buying power in the last year—as measured by an increase in program acquisition unit cost—depriving DOD of funding that could have been used for additional quantities or other priorities.
8. About 40 percent of the programs have experienced cost increases in the past year that exceed cost growth targets discussed by DOD, the Office of Management and Budget (OMB), and GAO; and over 50 percent exceeded the targets for growth in the past 5 years and since the first full estimate.
9. Looking forward, the number of programs in DOD's 2012 portfolio is projected to be the smallest since 2004 as more programs continue to leave the portfolio than enter it—a positive sign that DOD is adjusting its number of programs to meet resources.

[a] All dollar figures are in fiscal year 2012 constant dollars, unless otherwise noted.

[b] Discussion of growth in the 2011 portfolio does not include BMDS as DOD does not consider adjustments to this system to represent cost growth because the program has been allowed to add 2 years of new funding with each biennial budget. See GAO, *Missile Defense: Actions Needed to Improve Transparency and Accountability*, GAO-11-372 (Washington, D.C.: Mar. 24, 2011) for an assessment of the Missile Defense Agency's (MDA) cost, schedule, testing, and performance progress in developing BMDS.

Additional details about each observation follow.

- **The total cost of DOD's 2011 portfolio of major defense acquisition programs has grown by over $74 billion, or 5 percent, in the last year.** The over $74.4 billion in cost growth over the past year consists of a rise in development costs of $13.7 billion, or 4 percent, and an increase in procurement costs of $60.6 billion, or 5 percent. When measured from their first full estimates, which have been put in place over a number of years, the growth in total acquisition cost for these programs is $447 billion, or 40 percent. In addition, programs continue to deliver capabilities later than anticipated, with the average delay increasing by 1 month in the past year, and averaging 23 months when measured against a program's first full estimate. Table 1 shows the increases in programs' estimated cost and schedule over the last year, and appendix II presents our analysis of cost growth and delays over the past 5 years and against first full estimates.

Table 1: Changes in DOD's 2011 Portfolio of 96 Major Defense Acquisition Programs over the Past Year

Fiscal year 2012 dollars in billions

	Estimated portfolio cost in 2010	**Estimated portfolio cost in 2011**	**Estimated portfolio growth since 2010[a]**	**Percentage growth since 2010**
Total estimated research and development cost	$310	$324	$14	4%
Total estimated procurement cost	1,160	1,221	61	5
Total estimated acquisition cost[b]	1,503	1,578	74	5
Average delay in delivering initial capabilities	—	—	1 month	2

Source: GAO analysis of DOD data.

Note: Figures may not add due to rounding.

[a] The portfolio cost columns do not include the reported cost or cost growth of BMDS. DOD does not consider changes in BMDS costs to represent cost growth because the program has been allowed to add 2 years of new funding with each biennial budget.

[b] In addition to research and development and procurement costs, total acquisition cost includes acquisition-related operation and maintenance and system-specific military construction costs. Details on program costs used for this analysis are provided in app. III.

- **Quantity changes account for almost $30 billion of the nearly $61 billion in procurement cost growth over the last year.** Of the $60.6 billion in procurement cost growth realized in the past year, $29.6 billion is attributable to adjustments in quantities on 36 programs.[3] Twenty-two programs experienced procurement cost increases due to added quantities. The Littoral Combat Ship reported its total planned procurement for the first time in 2010 and accounts for most of this increase.[4] Fourteen programs experienced procurement cost decreases due to reductions in quantities. The Expeditionary Fighting Vehicle and Medium Extended Air Defense System, which had their production quantities reduced significantly after they were cancelled, account for most of the decrease. The remaining $31.1 billion in procurement cost growth cannot be attributed to quantity changes and is indicative of production problems and inefficiencies or flawed initial cost estimates. For example, the cost to procure the Joint Strike Fighter rose by almost $35 billion because of manufacturing inefficiencies, parts shortages, and quality issues; the number of aircraft procured did not change. Other programs, such as the Virginia-class submarine and the E-2D Advanced Hawkeye, were able to reduce their expected procurement costs without reducing quantities, by improving production processes or negotiating contracts with terms more favorable to the government. Table 2 shows how procurement costs changed across the DOD portfolio due to changes in planned procurement quantities as well as other factors.

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[3] To calculate the portion of procurement cost growth attributable to quantity changes, we compared a program’s quantities from the December 2009 SAR with its quantities from the December 2010 SAR. When quantities changed, we multiplied the change by the previous average procurement unit cost, using the December 2009 SAR estimate where available, to determine the expected cost growth or decrease due to these quantity changes. The Joint Tactical Radio System Handheld, Manpack, and Small Form Fit changed the mix as well as the quantity of radios procured but this change to radio type is not accounted for in our calculations. The Gray Eagle unmanned aircraft program changed how it calculates quantities for the 2010 SAR. We based our calculation on the change in procurement cost due to quantity for that program on the number of aircraft procured to account for this. See app. I for additional information on our scope and methodology.

[4] The Littoral Combat Ship program was initiated in May 2004 with an acquisition program baseline that included 2 procurement-funded ships. The program did not report its total planned procurement quantity of 53 ships until the December 2010 SAR.

Table 2: Change in Procurement Cost Due to Quantity Changes and Other Factors

Fiscal year 2012 dollars in billions

	Number of programs	Actual cost change	Estimated cost change directly attributable to quantity changes	Estimated cost change not directly attributable to quantity changes
Programs with quantity increases	22	$53.6	$63.0	-$9.3
Programs with quantity decreases	14	-28.1	-33.4	5.2
Programs with no change in quantity	59	35.2	0	35.2
Total	**95[a]**	**$60.6**	**$29.6**	**$31.1**

Source: GAO analysis of DOD data.

Note: Figures may not add due to rounding.

[a] The analysis does not include BMDS.

- **Many of the programs with the highest amounts of research and development cost growth in the last year are in production and are utilizing concurrent development and production strategies or funding modernization or upgrade efforts.** Over the past year, the research and development cost associated with the 2011 portfolio has risen 4 percent, or roughly $14 billion, and programs in production account for the overwhelming majority of this growth. This runs counter to what one might expect, namely that programs in production are beyond the point of development cost increases. Table 3 lists examples of these programs and the reasons they cited for their research and development cost growth in the past year.

Table 3: Examples of Programs with Significant Research and Development Cost Growth in the Past Year

Program	Growth in last year (dollars in millions)	Reason for growth	Start of production
Joint Strike Fighter	$3,922	Additional funding to reduce risk	2007
Space Based Infrared System High Program	785	Additional funding needed to meet requirements	2001
F-22 Raptor	780	Additional funding for modernization	2001
P-8A Poseidon	742	Additional funding for new increment of capability, correction of deficiencies, and updated estimates	2010
Virginia-class Submarine	727	Additional funding for enhancements, cost reduction initiatives, and testing	1997
Global Hawk	722	Additional funding for the inclusion of new capabilities and testing	2001
DDG 51 Destroyer	656	Additional funding for the inclusion of new capabilities	1985
Trident II Missile	624	Additional funding for modernization and replacement	1987
Apache Block IIIA Remanufacture	506	Additional funding for software development	2010

Source: GAO analysis of DOD data.

Several of these programs, including the Joint Strike Fighter, Space Based Infrared System High, and Apache Block IIIA Remanufacture, have concurrent development and production strategies, which increases manufacturing risk and can result in increased cost and schedule if problems are discovered late in design or production. Other programs, such as the F-22 Raptor, Virginia-class submarine, DDG 51 Destroyer, and Trident II Missile, have begun efforts to add capability to or modernize the system within the existing program. The P-8A Poseidon and Global Hawk have done both. According to DOD's primary acquisition policy—Department of Defense Instruction 5000.02—upgrades, improvements, and similar efforts that provide a significant increase in operational capability and meet the major defense acquisition program threshold should be managed as separate increments.[5] None of the efforts in these six programs were being managed as separate increments.

- **The cost of the portfolio is driven by the 10 highest-cost programs, which account for 55 percent of the total.** DOD's portfolio of major defense acquisition programs is unbalanced. As shown in table 4, the 10 highest-cost programs account for 55 percent, or roughly $868 billion, of the 2011 portfolio's $1.58 trillion total acquisition cost. These programs are also driving overall portfolio outcomes and account for over $53 billion, or about 72 percent, of the total cost growth for the portfolio in the past year. All 10 of these programs are currently in production and all but three—the Joint Strike Fighter, the CVN 78 Class, and the P-8A Poseidon—have attained initial operational capability.

Table 4: Ten Highest-Cost Acquisition Programs in 2011 Portfolio

Fiscal year 2012 dollars in billions

Program	Total acquisition cost	Percent of 2011 portfolio cost
Joint Strike Fighter	$327	21
DDG 51 Destroyer	102	6
Virginia-class Submarine	84	5
F-22 Raptor	79	5
F/A-18E/F Super Hornet	58	4
V-22 Osprey	57	4
Trident II Missile	53	3
Joint Mine Resistant Ambush Protected Vehicle	42	3
CVN 78 Class	34	2
P-8A Poseidon	33	2
Total	**$868**	**55**

Source: GAO analysis of DOD data.

Note: Figures may not add due to rounding.

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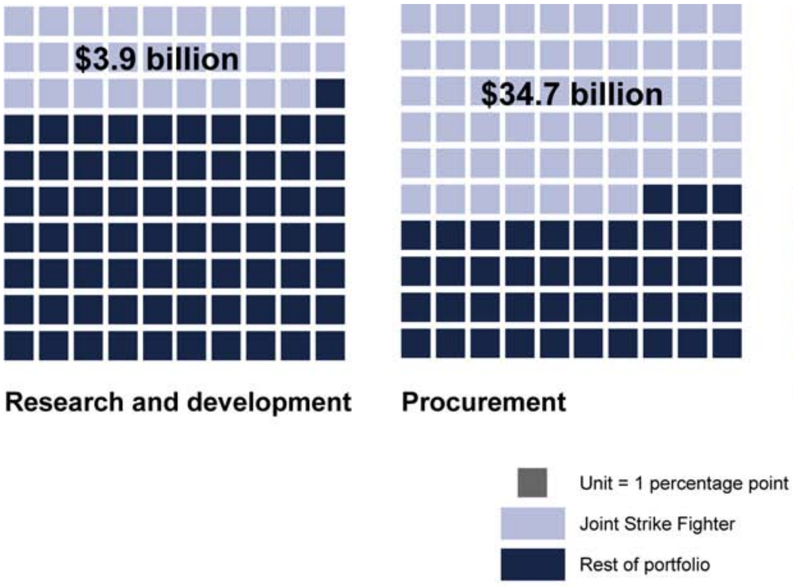
[5] Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System* enc. 2, para. 2.(c) (Dec. 8, 2008).

- **The Joint Strike Fighter is driving much of DOD's poor portfolio performance and it will continue to drive outcomes for the foreseeable future.** Among the 96 programs in DOD's 2011 portfolio, the Joint Strike Fighter is the costliest, the poorest performer in terms of cost growth, and the program with the largest remaining funding needs. The Joint Strike Fighter accounts for 21 percent, or nearly $327 billion, of the planned total acquisition cost of the portfolio. It is also responsible for the most significant research and development, procurement, and total acquisition cost growth in the past year, as shown in figure 1. This growth took place without any change in procurement quantities by the program.

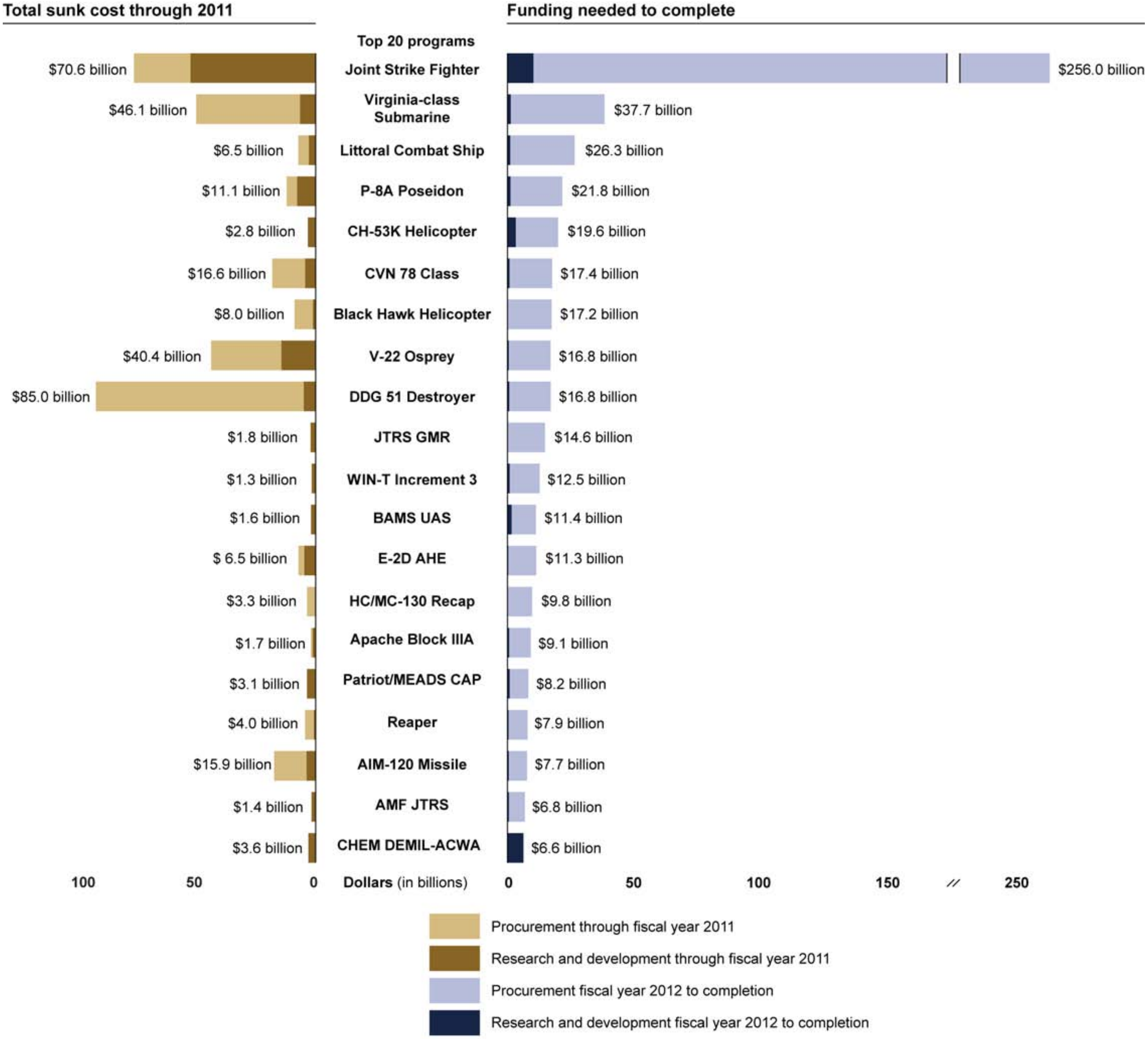
Figure 1: Joint Strike Fighter as a Portion of 2011 Portfolio Cost Growth



Source: GAO analysis of DOD data.

- **Most of the remaining funding for the 2011 portfolio is for procurement.** Over 91 percent of the almost $705 billion needed to complete the programs in the 2011 portfolio consists of procurement funding; therefore, any future funding cuts to these programs will likely result in quantity reductions. The Joint Strike Fighter program alone is expected to account for 38 percent—or almost $246 billion—of the future procurement funding needed. This amount is enough to fund the remaining procurement costs of the next 15 largest programs. Figure 2 shows the funding spent and still needed for the 20 programs with the highest remaining funding needs.

Figure 2: Twenty Costliest Acquisition Programs by Funding Needed to Complete



Source: GAO analysis of DOD data.

Note: BMDS is excluded from this analysis. JTRS GMR is the Joint Tactical Radio System Ground Mobile Radios; this program was terminated during the course of our review. WIN-T Increment 3 is the third increment of the Warfighter Information Network-Tactical program. BAMS UAS is the Broad Area Maritime Surveillance Unmanned Aircraft System. E-2D AHE is the Advanced Hawkeye. HC/MC-130 Recap is the recapitalization program for the HC/MC-130 aircraft. Patriot/MEADS CAP is the Patriot/Medium Extended Air Defense System Combined Aggregate Program. AMF JTRS is the Airborne and Maritime/Fixed Station Joint Tactical Radio System. CHEM-DEMIL ACWA is Chemical Demilitarization-Assembled Chemical Weapons Alternatives.

- **Buying power, as measured by program acquisition unit cost, has decreased for over 60 percent of programs over the past year.** Of the 96 programs or components in DOD’s portfolio that reported program acquisition unit cost data, 61 are planning to deliver capabilities at higher unit costs than estimated a year ago while 35 are planning to deliver capabilities at or below the same estimates.[6] Unit costs are sensitive to how many are being bought. If quantities are decreased, unit costs would be expected to go up and vice versa. However, only 11 of the 61 programs with unit-cost increases in the past year decreased quantities in the past year, indicating that unit-cost growth in the other 50 cases was due to actual research and development or procurement cost growth—not changes in quantities. We did not examine whether these programs delivered a higher or lower level of performance than initially planned.

- **Less than half of the programs in the 2011 portfolio met cost-growth targets used to measure DOD’s progress on addressing GAO’s weapon system acquisition high-risk area.** In December 2008, DOD, OMB, and GAO discussed a set of cost growth metrics and goals to evaluate DOD’s progress on improving program performance for purposes of our high-risk report. These metrics were designed to capture total cost-growth performance over 1-year and 5-year periods as well as from the original program estimate on a percentage basis as opposed to dollar amount to control for the disparity in the amount of funding between programs. As shown in figure 3, 40 percent of major defense acquisition programs did not meet the criteria for less than 2

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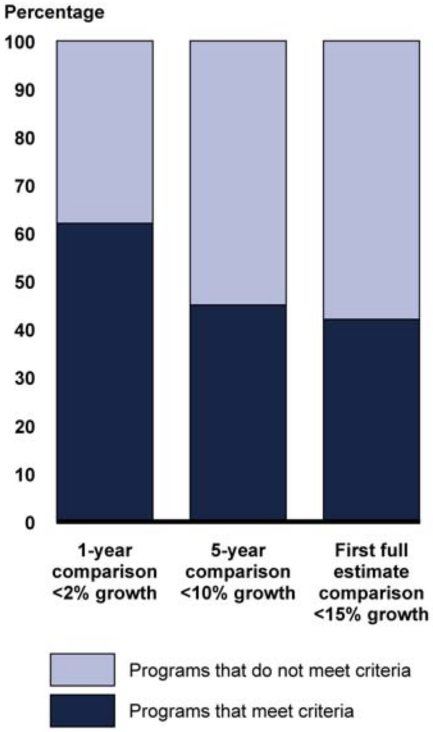
[6] Program acquisition unit cost is the total cost for development, procurement, acquisition operation and maintenance, and system-specific military construction for the acquisition program divided by the number of items to be produced. DOD’s 2011 portfolio includes 96 programs with SARs; however, DOD’s SAR summary tables break down several of these programs into smaller elements. We did not include BMDS or the National Polar-orbiting Operational Environmental Satellite System because comparable cost and quantity data were not available, or the Expeditionary Fighting Vehicle and Patriot/Medium Extended Air Defense System Combined Aggregate Program Fire Unit, because these programs were cancelled.

percent growth in total acquisition cost over the past year, and over half did not meet the less than 10 percent metric for growth over a 5-year period and the less than 15 percent metric from their first full estimate. When measured against the same criteria for growth using program acquisition unit cost or average procurement unit cost, the percent of programs that do not meet the criteria remain roughly the same.

Figure 3: Programs Meeting High-Risk Cost Metrics



Source: GAO analysis of DOD data.

Notes: The number of programs represents those in the 2011 portfolio—those with December 2010 SARs—which break down several programs into smaller elements for reporting purposes. One program, Airborne Signals Intelligence Payload (ASIP), was not included in the 5-year comparisons because data were not available to make that comparison. BMDS was not included in this analysis.

- **The number of programs in DOD's portfolio decreased in fiscal year 2011 and, looking forward, is expected to decrease again in the next fiscal year to its lowest level since 2004.** DOD's portfolio for 2011 contains 96 major defense acquisition programs, a net decrease of 2 since last year. Six programs left the portfolio and four programs entered.[7] The six programs that left the portfolio cost an estimated $108 billion to develop and produce, and the four new entries are expected to cost $29 billion. Based on DOD data on programs that will enter and exit the portfolio in fiscal year 2011, we project that the number of programs and DOD's total planned investment in them will decrease again in the next fiscal year.[8] As shown in figure 4, the expected decrease would reduce the number of programs to its lowest level since 2004.

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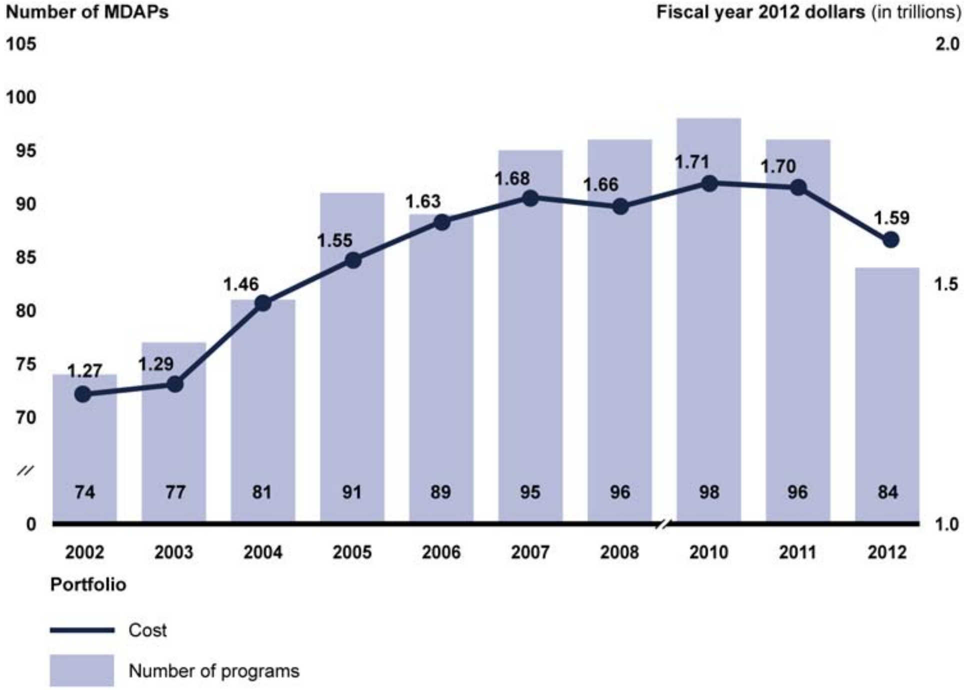
[7] The six programs that exited the portfolio were Bradley armored fighting vehicle upgrade, C-17A aircraft, CVN 68 aircraft carrier, EA-6B Improved Capability III aircraft, Minuteman III Propulsion Replacement Program, and the MQ-1B Predator unmanned aircraft. The four that entered were Apache Block IIIB New Build helicopter, HC/MC-130 Recapitalization program, KC-130J aircraft, and Small Diameter Bomb Increment II.

[8] The programs exiting the portfolio in 2012 will do so because of cancellation or delivery of 90 percent of end items. Programs include: Airborne Signals Intelligence Payload, Advanced Threat Infrared Countermeasure/Common Missile Warning System, B-2 Radar Modernization Program, C-5 Avionics Modernization Program, Expeditionary Fighting Vehicle, F-22 Raptor, Force XXI Battle Command Brigade and Below, Increment 1 Early-Infantry Brigade Combat Team, Joint Mine Resistant Ambush Protected vehicle, Large Aircraft Infrared Countermeasures, Longbow Apache, Space Based Space Surveillance Block 10, and the Lewis and Clark-class Dry Cargo/Ammunition ship (T-AKE). The one program that is currently scheduled to become a major defense acquisition program and begin annual selected acquisition reporting in fiscal year 2012 is the KC-46 Tanker Modernization Program.

Figure 4: Number of Programs in DOD Portfolio over the Past 10 Years



Source: GAO analysis of DOD data.

Note: The 2009 portfolio is excluded because there were no annual SARs released for 2008. The 2012 portfolio is projected from DOD data.

It is not clear whether this reduction in the number of programs in the portfolio is the result of DOD's recognition of the increasing constraints on the defense budget and the beginning of a longer-term trend or whether it is a 1-year anomaly resulting from a number of large and capital-intense programs, such as F-22 and the Joint Mine Resistant Ambush Protected vehicle, leaving the portfolio. Regardless, if the cost growth of the programs remaining in the portfolio can be controlled, the end result would be a better balance between the number of programs and DOD's available resources.

Observations from Our Assessment of Knowledge Attained by Programs That Have Not Yet Reached Full-Rate Production

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 acquisitions 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 by critical points in the acquisition process.[9] On the basis of this work, we have identified three key knowledge points during the acquisition cycle—development start, critical design review, and production start—at which programs need to demonstrate critical levels of knowledge to proceed.[10] 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.

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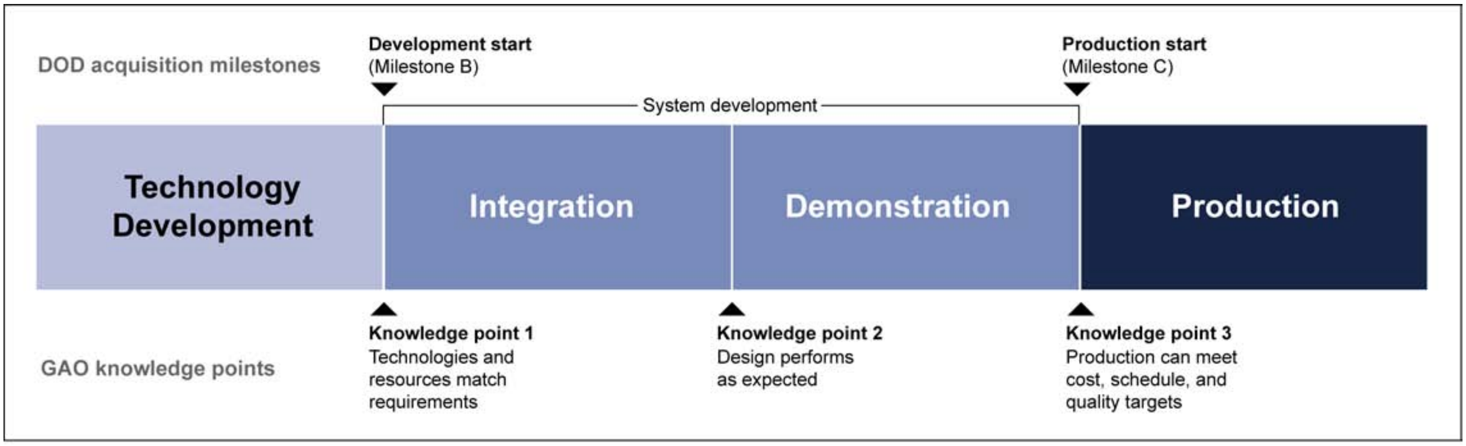
[9] GAO, *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, GAO/NSIAD-99-162 (Washington, D.C.: July 30, 1999); GAO, *Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes*, GAO-01-288 (Washington, D.C.: Mar. 8,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

[10] For shipbuilding programs, we have identified two key knowledge points during the acquisition cycle—detail design contract award and fabrication start.

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



Source: GAO.

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 increases funding predictability. For shipbuilding programs, critical technologies should be matured into actual system prototypes and successfully demonstrated in a realistic environment before a contract is awarded for detail design of a new ship.

Knowledge point 2: Product design is stable. This point occurs when a program determines that a product's design will meet customer requirements, as well as cost, schedule, and reliability targets. A best practice is to achieve design stability at the system-level critical design review, usually held midway through system development. Completion of at least 90 percent of engineering drawings at this point provides tangible evidence that the product's design is stable, and a prototype demonstration shows that the design is capable of meeting performance requirements. Shipbuilding programs should demonstrate design stability by completing 100 percent of the basic and functional drawings as well as the three-dimensional product model, when employed, 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 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.

A knowledge-based acquisition approach is a cumulative process in which certain knowledge is acquired by key decision points before proceeding. 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 likewise 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.

Overall, we assessed the knowledge attained by key junctures in the acquisition process for 37 individual weapon programs, which are mostly in development or early production.[11] In particular, we focused on the eight

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[11] Not all programs provided information for every knowledge point or had reached all of the knowledge points—development start, design review, and production start. Because knowledge points and best practices differ for shipbuilding programs, we exclude the five shipbuilding programs in our assessment from some of our analysis.

programs from this group that progressed through key acquisition points in 2011—one program began system development, four programs held critical design reviews, and three programs began production. Only one of these eight programs—Excalibur Increment Ib—implemented all of the applicable knowledge-based acquisition practices at these points; and overall, most of the 37 programs we assessed are not fully adhering to a knowledge-based approach, putting them at higher risk of cost growth and schedule delays. Our analysis of the eight programs that went through key acquisition points in 2011 allows us to make three observations.

Knowledge Point Observations

1. The one program that began system development in 2011 did so with all of its critical technologies nearing maturity, but without demonstrating them in a realistic environment.
2. Three of four programs that held critical design reviews in 2011 did so with stable designs, but only one tested an integrated prototype to demonstrate that the design was capable of meeting performance requirements.
3. One of the three programs that held a production decision in 2011 reported that its critical manufacturing processes were in control; one of the three programs demonstrated their production processes on a pilot production line; and two of the three programs tested production-representative prototypes to demonstrate reliable performance.

Additional detail about these observations follows.

- **The only program in our assessment that began development in 2011 did so with all of its critical technologies nearing maturity, but without demonstrating them in a realistic environment.** The KC-46 tanker began development with all its critical technologies at least nearing maturity—that is, demonstrated in a relevant environment—in accordance with DOD policy and statutory requirements.[12] Models of these technologies were demonstrated on other aircraft or in simulations. However, knowledge-based acquisition

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[12] According to DOD policy, in order to be considered mature enough to use in product development, technology shall have been demonstrated in a relevant environment or, preferably, in an operational environment. Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System*, enc. 2, para. 5.d(4). In addition, a major defense acquisition program may not receive milestone B approval (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).

practices recommend and DOD policy prefers that programs fully mature technologies and demonstrate them in a realistic or operational environment prior to entering system development, to gain additional knowledge about the technologies' form, fit, and function as well as the effect of the intended environment on those technologies.[13] Our analysis of the 37 programs in our assessment that provided technology data shows that 20 programs reported having all critical technologies at least nearing maturity prior to entering system development, with only 4 of those fully maturing their technologies. Of the five shipbuilding programs we assessed, only one had all its critical technologies fully mature before awarding its detailed design contract, the point at which technology maturity should be achieved.

Key acquisition practices also recommend, and statute requires, that programs hold systems engineering events, such as a preliminary design review, before development start to ensure that requirements are defined and feasible and that the proposed design can meet those requirements within cost, schedule, and other system constraints.[14] The KC-46 program received a waiver to enter development without conducting a preliminary design review, and plans to hold it in March 2012, about 13 months after development start. Overall, 29 of the 37 programs we assessed failed to hold preliminary design reviews prior to the start of development or the award of their detailed design contracts. Our analysis shows that these programs experienced, on average, more research and development cost growth and total acquisition cost growth than programs that held the review before these points.

Knowledge-based acquisition practices also recommend limiting the time a program or an increment of a program spends in development to

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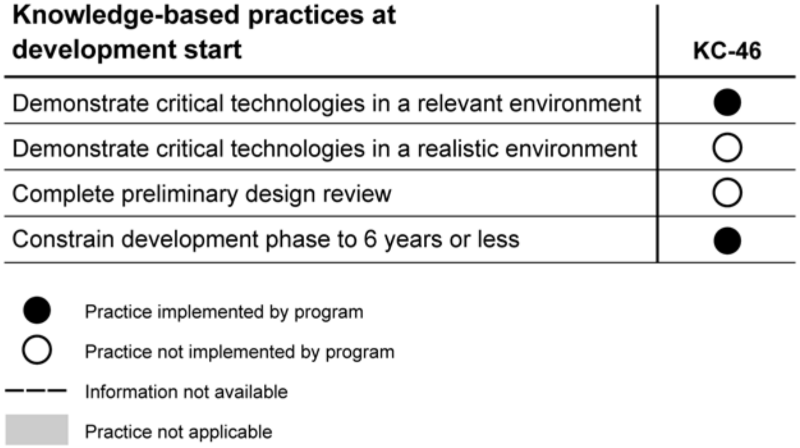
[13] Demonstration in a relevant environment is Technology Readiness Level (TRL) 6. Demonstration in a realistic environment is TRL 7. See app. V for a detailed description of TRLs.

[14] GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, GAO-09-326SP (Mar. 30, 2009). 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 postpreliminary design review assessment and certified on the basis of such assessment that the program demonstrates a high likelihood of accomplishing its intended mission. 10 U.S.C. § 2366b(a)(2).

5 or 6 years, and the KC-46 program plans to do so.[15] Constraining development time in this manner increases the predictability of funding needs as well as the likelihood of program success. Of the 32 programs whose development cycles we assessed, 21 currently plan to constrain their development time to 6 years or less. We did not assess shipbuilding programs against this metric as their development cycles do not align in a manner consistent with other programs. Figure 6 summarizes the KC-46 program's implementation of knowledge-based acquisition practices related to development start.

Figure 6: Implementation of Knowledge-Based Practices by a Program Beginning System Development in 2011



Knowledge-based practices at development start	KC-46
Demonstrate critical technologies in a relevant environment	●
Demonstrate critical technologies in a realistic environment	○
Complete preliminary design review	○
Constrain development phase to 6 years or less	●

● Practice implemented by program
○ Practice not implemented by program
——— Information not available
▨ Practice not applicable

Source: GAO analysis of DOD data.

- **Three of four programs in our assessment that held a critical design review in 2011 demonstrated that their designs were stable, but only one showed that its design would perform as intended.** Knowing a product's design is stable before system demonstration reduces the risk of costly design changes occurring during manufacturing of production-representative prototypes—when investments in acquisition become more significant. For shipbuilding

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[15] Additionally, DOD policy provides that a condition for exiting the technology development phase is that a system or increment can be developed for production within a short time frame, defined as normally less than 5 years for weapon systems. Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System*, enc. 2, para. 5.d(7).

programs, starting fabrication of the lead ship with a stable design can minimize out-of-sequence work and rework, as Navy lead ships often become the platform upon which planned capabilities are eventually proven. Three of the four programs that completed a critical design review in 2011 stabilized their designs by releasing at least 90 percent of their total expected design drawings. Overall, 8 of the 37 programs we assessed released over 90 percent of their total expected design drawings before holding a critical design review or, for ships, demonstrated stable designs by completing 100 percent of their three-dimensional design models prior to the start of fabrication.

We have previously reported that early system prototypes are useful to demonstrate that the design will work as anticipated and can be built within cost and schedule. Only one of the four programs that held its critical design review in 2011—the Excalibur Increment Ib—demonstrated that its design was capable of meeting performance requirements by testing an integrated prototype before the design review. On average, the other three programs plan to test an integrated prototype 15 months after the critical design review, similar to the 13-month average we reported in last year’s assessment. Overall, only 5 of the 32 programs we assessed for this purpose tested a system-level integrated prototype by the time of their critical design review. We did not assess shipbuilding programs against this metric as testing a system-level prototype in these programs may not be practical.

Reliability growth testing provides visibility over how reliability is improving and uncovers design problems so fixes can be incorporated before production begins. Three of the four programs that held a critical design review in 2011 established a reliability growth curve. Overall, 18 of the 37 programs we assessed had a reliability growth curve by the same point. Figure 7 shows how the four programs that held critical design reviews in 2011 performed against these and other knowledge-based practices.

Figure 7: Implementation of Knowledge-Based Practices by Programs Holding Critical Design Reviews in 2011

Knowledge-based practices at critical design review	BAMS UAS	Excalibur Inc. Ib	Reaper	SDB II
Demonstrate critical technologies in a realistic environment	●	●	●	○
Release at least 90 percent of design drawings	○	●	●	●
Test a system-level integrated prototype	○	●	○	○
Use a reliability growth curve	●	●	○	●
Conduct producibility assessments to identify manufacturing risks for key technologies	○	▨	●	●
Identify key product characteristics	●	●	○	●
Identify critical manufacturing processes	▨	▨	●	●
Complete failure modes and effects analysis	●	▨	○	●

● Practice implemented by program

○ Practice not implemented by program

— — — Information not available

▨ Practice not applicable

Source: GAO analysis of DOD data.

Note: BAMS UAS is the Broad Area Maritime Surveillance Unmanned Aircraft System. SDB II is the Small Diameter Bomb Increment II.

- **One of the three programs that held a production decision in 2011 had its critical manufacturing processes in control; one of the three demonstrated production processes on a pilot production line; and two of the three tested production-representative prototypes.** 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. For example, bringing processes under statistical control reduces variations in parts manufacturing, thus reducing the potential for defects, and is generally less costly than performing extensive inspection after a product is built. One of the three programs that held a production decision in 2011—Global Positioning System

III—provided data that demonstrated its critical manufacturing processes were in control at production start.[16] Overall, 4 of the 32 programs in our production assessment provided data demonstrating their critical processes were in control. It is also DOD policy for manufacturing processes to be effectively demonstrated in a pilot-line environment before entering production.[17] One of the three programs that held a production decision in 2011—Joint Air-to-Surface Standoff Missile–Extended Range (JASSM-ER)—demonstrated its critical processes on a pilot production line. Overall, 26 of 32 programs reported that they have or planned to demonstrate their critical processes on a pilot line before production start.

Production and postproduction costs are also minimized when a fully integrated, capable prototype is demonstrated to show that the system will work as intended in a reliable manner. Since 2008, DOD policy has also required that a system be demonstrated in its intended environment using a production-representative article before entering production, which has led to an increase in the number and percentage of programs doing so.[18] Two of three programs that held production decisions in 2011 tested production-representative prototypes before committing to production. Overall, according to our analysis of survey results, one of the six programs that held their production decisions prior to 2009 tested production-representative prototypes prior to production start; and 15 of the 24 programs that have held or will hold production decisions after 2009 have tested or plan to test a production-representative prototype before those decisions. Figure 8 shows how the three programs that held production decisions in 2011 performed against relevant knowledge-based practices.

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[16] In addition to using Process Capability Index data to determine whether critical processes are in control, we used data from manufacturing readiness level assessments of the process capability and control sub-thread to assess production process maturity. For more information on our methodology see app. I.

[17] Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System*, enc. 2, para. 6 (c)(6)(d).

[18] Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System*, enc. 2, para. 6 (c)(6)(d).

Figure 8: Implementation of Knowledge-Based Practices by Programs Holding Production Decisions in 2011

Knowledge-based practices at production decision	GPS III	JASSM-ER	JTRS HMS
Demonstrate critical technologies in a realistic environment[a]	●	●	○
Release at least 90 percent of design drawings	○	●	●
Demonstrate critical processes are in control	●	○	○
Demonstrate critical processes on a pilot production line	○	●	○
Test a production-representative prototype	○	●	●

● Practice implemented by program

○ Practice not implemented by program

——— Information not available

▨ Practice not applicable

Source: GAO analysis of DOD data.

Note: GPS III is the Global Positioning System III. JASSM-ER is the Joint Air-to-Surface Standoff Missile–Extended Range. JTRS HMS is the Joint Tactical Radio System Handheld, Manpack, and Small Form Fit.

[a] Critical technologies for the GPS III were demonstrated in a relevant environment which is considered mature for satellites.

Observations about DOD's Implementation of Acquisition Policy Reforms

In the past few years, a number of acquisition reform initiatives have been introduced both through legislation and through efforts undertaken by DOD; specifically the Weapon Systems Acquisition Reform Act of 2009, the reissuance of DOD Instruction 5000.02, and the Under Secretary of Defense for Acquisition, Technology and Logistics' "Better Buying Power" memorandum.[19] We assessed the implementation of four sections of the Weapon Systems Acquisition Reform Act of 2009, including requirements for major defense acquisition programs to: (1) conduct preliminary design

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[19] Pub. L. No. 111-23. Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System* (Dec. 8, 2008); Office of the Under Secretary of Defense, Acquisition, Technology and Logistics Memorandum: "Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending" (Sept. 14, 2010).

reviews before development start; (2) demonstrate capabilities using competitive prototypes; (3) ensure that appropriate trade-offs among cost, schedule, and performance objectives are considered before development start; and (4) include measures to ensure competition or the option of competition throughout the programs’ life cycle in their acquisition strategies. We also assessed a new requirement from the 2008 revision to DOD Instruction 5000.02 for a materiel development decision prior to a program’s entry into the acquisition process and two initiatives from DOD’s September 2010 better buying power memorandum focusing on affordability and “should cost” targets. Many of these reforms and others depend on increased investments of time and resources at the beginning of the acquisition process and encourage an awareness of cost performance throughout a program’s life cycle. Increased funding of technology development can have beneficial effects for acquisition programs if the funds are spent on activities appropriate for that phase, such as prototype demonstrations and systems engineering analysis.

Our analysis of 16 future and 37 current major defense acquisition programs allows us to make three observations concerning DOD’s progress in implementing these reforms.

Acquisition Reform Observations

1. Almost all of the future major defense acquisition programs we assessed have implemented or plan to implement acquisition reforms from the Weapon Systems Acquisition Reform Act of 2009; current programs have a mixed record in regards to implementing certification requirements from the act, such as considering appropriate trade-offs among cost, schedule, and performance objectives.

2. Some future programs have not implemented the new DOD policy requirement to hold a materiel development decision, and many future and current programs are still working to implement new initiatives, such as developing affordability targets and conducting "should cost" analysis.

3. The 16 future major defense acquisition programs we assessed are investing more funds before entering system development or production than current major defense acquisition programs, which should reduce their technical risk.

Additional information about these observations follows.

- **Almost all future programs have implemented, or plan to implement, most of the legislative reforms we examined. Current programs have waived several of the newest certification requirements.** The Weapon Systems Acquisition Reform Act of 2009 introduced a requirement for a preliminary design review to be held for all major defense acquisition programs before the start of system development.[20] Eleven of the 16 future major defense acquisition programs in our assessment intend to conduct such a review in accordance with the act. Four of the remaining programs have not yet established a date for their preliminary design reviews; the fifth program is not required to hold a preliminary design review because it expects to enter the acquisition cycle at production start.

The Weapon Systems Acquisition Reform Act of 2009 also requires the acquisition strategy for major defense acquisition programs to provide for use of competitive prototypes before a program enters system development, which can provide a program with an opportunity to reduce technical risk, refine requirements, validate designs and cost estimates, and evaluate manufacturing processes. According to the results of our survey, 13 of the 16 future programs in our assessment intend to develop prototypes of the proposed weapon system or key subsystems before development start. Three programs do not intend to use prototyping and two of those programs intend to seek a waiver from the prototyping requirement, as provided by the act. The program that does not intend to seek the waiver—the Common Vertical Lift Support Platform—is proceeding directly to production and the competitive prototyping requirement is not applicable.

A requirement for major defense acquisition programs to have acquisition strategies that ensure competition or the option of competition throughout the acquisition life cycle was also included in the Weapon Systems Acquisition Reform Act of 2009.[21] Use of competition throughout a program's life cycle can help to reduce program costs. Measures to ensure competition or the option of competition may include developing competitive prototypes, using modular open architectures to enable competition for upgrades, and holding periodic system or program reviews to address long-term competitive effects of program decisions. Eleven of the 16 future programs in our assessment intend to use these measures or options after development start. Figure 9 summarizes the progress in implementing selected acquisition reforms for future programs.

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[20] Pub. L. No. 111-23, § 205(a).

[21] Pub. L. No. 111-23, § 202.

Figure 9: Progress in Implementing Selected Reforms in Future Major Defense Acquisition Programs

System	Hold preliminary design review	Competitive prototyping	Competitive acquisition strategy
Three Dimensional Expeditionary Long Range Radar	●	●	●
Air and Missile Defense Radar	●	●	●
B-2 Defensive Management System Modernization	TBD	●	○
B-2 Extremely High Frequency SATCOM Capability Increment 2	TBD	●	○
Combat Rescue Helicopter	TBD	○	●
Common Vertical Lift Support Platform	▨	▨	●
Enhanced Polar System	●	○	○
Ground Combat Vehicle	TBD	●	●
Global Positioning System OCX Ground Control Segment	●	●	○
Joint Air-to-Ground Missile	●	●	○
Joint Light Tactical Vehicle	●	●	●
Littoral Combat Ship Mission Modules	●	●	●
Nett Warrior	●	●	●
Ohio-class Replacement	●	●	●
Space Fence	●	●	●
Ship to Shore Connector	●	●	●

● Practice implemented by program
○ Practice not implemented by program
TBD To be determined
▨ Practice not applicable or information not available

Source: GAO analysis of survey data.

The Weapon Systems Acquisition Reform Act of 2009 also required, as part of a mandatory program certification prior to development start, an analysis that appropriate trade-offs among cost, schedule, and performance objectives have been made to ensure the program is affordable.[22] The mandatory certification also requires that, before development start, a major defense acquisition program hold a

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[22] Pub. L. No. 111-23, § 201(f).

preliminary design review, have technology demonstrated in a relevant environment, have completed cost and schedule estimates with concurrence of the Director of Cost Assessment and Program Evaluation (CAPE), have funding available to execute the development and production of the program, perform an analysis to consider other alternatives, and have program requirements approved by the Joint Requirements Oversight Council. A waiver may be granted for any one or more provisions of this certification if it is determined that without the waiver the department would be unable to meet critical national security objectives. As shown in table 5, all three programs that received this certification in the past year—the KC-46 tanker, Littoral Combat Ship Seaframe, and DDG 1000 Destroyer—were granted waivers for multiple certification provisions.

Table 5: Certification Waivers Granted for Programs in 2011

Program	Waiver granted
KC-46 tanker	Trade-offs considered Full funding availability Preliminary design review held
Littoral Combat Ship Seaframe	Trade-offs considered Cost and schedule estimates with CAPE concurrence Full funding availability
DDG 1000 Destroyer	Trade-offs considered Full funding availability

Source: GAO analysis of DOD data.

Note: The DDG 1000 Destroyer program was required to be recertified following a Nunn-McCurdy unit-cost breach of the critical threshold. A breach of the critical cost growth threshold occurs when the program's acquisition unit cost or the procurement unit cost increases by at least 25 percent over the current baseline estimate or at least 50 percent over the original baseline estimate. 10 U.S.C. § 2433.

- **Some future programs have not implemented a DOD policy requirement to hold a materiel development decision, and a majority of future and current programs are still working to implement initiatives on developing affordability and "should cost" targets.** In 2008, DOD revised its primary acquisition policy to require a materiel development decision review as the formal entry point into the acquisition process. This review determines the acquisition phase where a program will enter the acquisition management system, and approves the parameters for analyzing the alternatives that might be able to address a defined capability need. Six of the 16 future programs we assessed have held or intend to hold this review.[23] Of the 10 future programs that did not hold a materiel development decision review, three—Three Dimensional Expeditionary Long Range Radar, Air and Missile Defense Radar, and Space Fence—began their respective technology development phases after DOD's policy instruction was revised in 2008.[24]

In September 2010, the Under Secretary of Defense for Acquisition, Technology and Logistics issued a memorandum intended to promote greater efficiency and productivity in defense spending. The memorandum emphasizes the need to treat affordability, defined as conducting a program at a cost constrained by the resources that DOD can allocate, as a key requirement akin to speed or power, and mandates establishing an affordability target at program start. According to our analysis of survey responses, 4 of the 16 future and 19 of the 37 current major defense acquisition programs we assessed have established affordability targets. For example, the Navy's planned Ohio-class submarine replacement program established an affordability target at the start of technology development. To assist in meeting this target, the Navy is working to identify areas where costs can be controlled by using existing technologies and aligning the program's production with the Virginia-class submarine. By incorporating these measures, the Navy expects to reduce the estimated cost of each submarine from $5.6 billion to $4.9 billion.

The Under Secretary's initiatives also emphasize the importance of driving cost improvements during contract negotiation and program execution. In accordance with direction provided in the memorandum, each program must conduct a "should cost" analysis justifying each element of the program with the aim of reducing negotiated prices for contracts. According to our analysis of survey responses, 6 of the 16 future and 23 of the 37 current major defense acquisition programs we assessed indicate that they have completed this type of analysis. For

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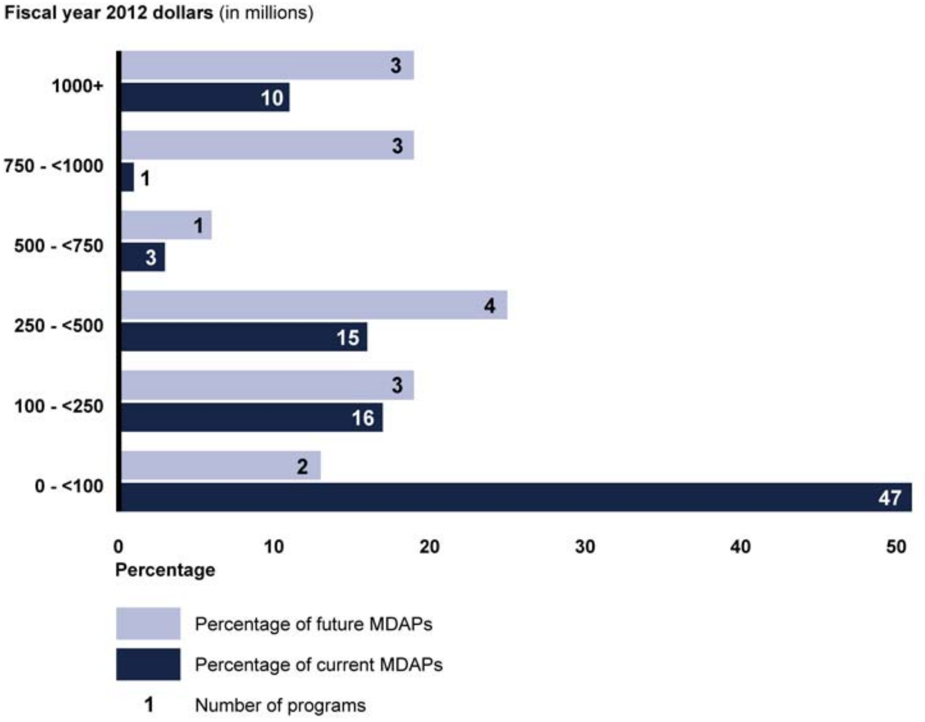
[23] These programs include: B-2 Defensive Management System Modernization, Common Vertical Lift Support Platform, Ground Combat Vehicle, Combat Rescue Helicopter, Ohio-class Replacement, and Ship to Shore Connector.

[24] The programs that do not plan to hold a materiel development decision include: Three Dimensional Expeditionary Long Range Radar, Air and Missile Defense Radar, B-2 Extremely High Frequency SATCOM Capability Increment 2, Enhanced Polar System, Global Positioning System III OCX Ground Control Segment, Joint Air-to-Ground Missile, Joint Light Tactical Vehicle, Littoral Combat Ship Mission Modules, Nett Warrior, and Space Fence.

example, the Navy's E-2D Advanced Hawkeye program completed a "should cost" analysis and used the knowledge gained to negotiate a 4.5 percent reduction in its third production contract.

- **The 16 future major defense acquisition programs we assessed intend to invest significantly more funds prior to entering system development or production than current programs.** Many of the recent acquisition reforms mandated by Congress or initiated by DOD increase knowledge prior to the start of system development. These activities help programs ensure that there is a match between requirements and resources before they begin, but they take money. As a result, DOD is beginning to allocate more funding earlier in a program's life cycle, according to our analysis of program spending plans. DOD spent over $450 million, on average, on 92 current major defense acquisition programs that reported cost data for the period prior to entering system development. For the 16 future programs in our analysis, DOD currently plans to spend an average of almost $700 million, or over $11 billion in total, before these programs begin system development or start production and bypass system development. See figure 10 for the amount of funding that future programs plan to spend and current programs spent.

Figure 10: Funding for Future and Current Programs during Technology Development



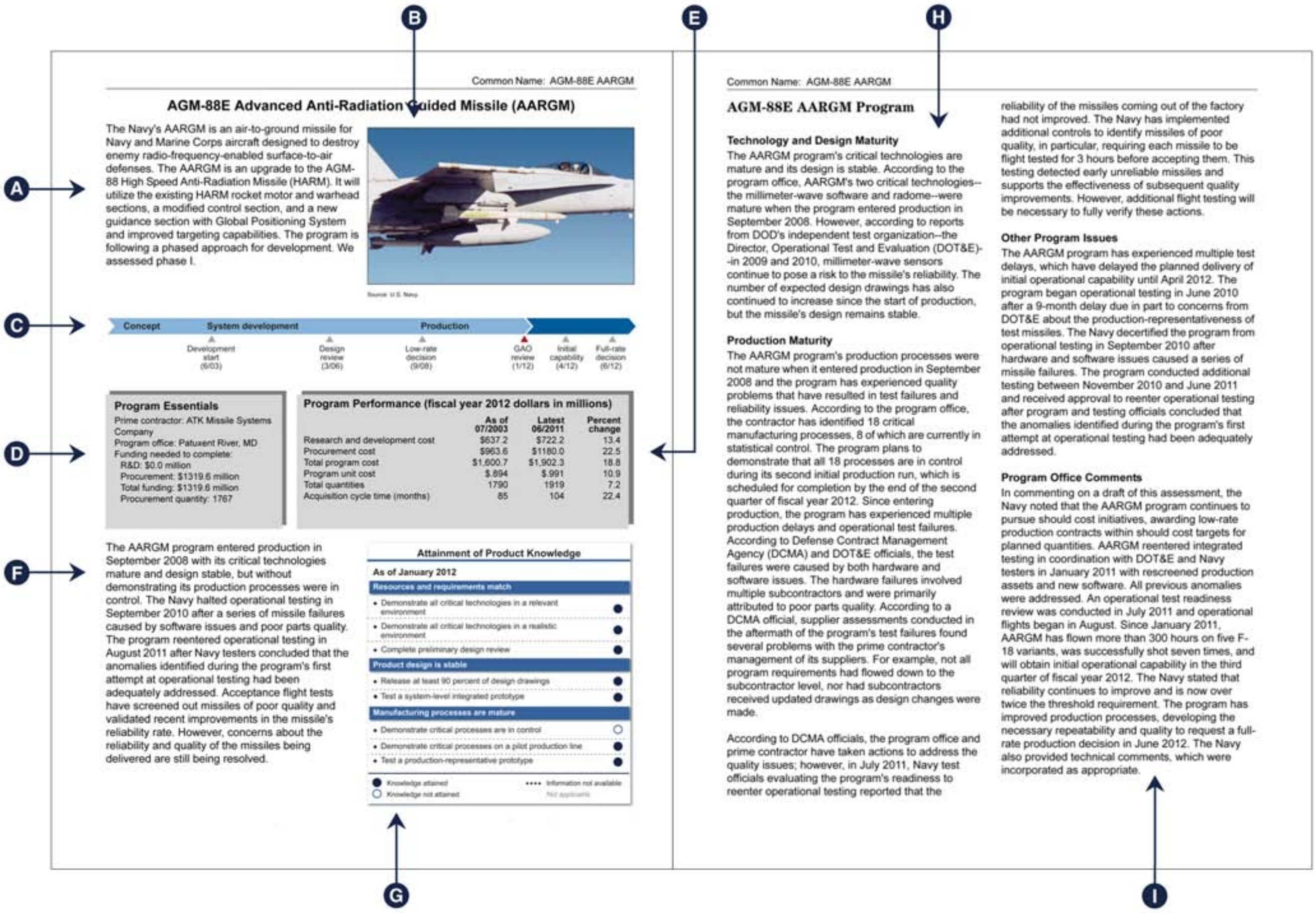
Source: GAO analysis of DOD data.

For example, the Navy’s Littoral Combat Ship Mission Modules and Ohio-class submarine replacement programs are projected to spend more than $1.2 billion and $2.4 billion respectively in technology development, and the Army’s Ground Combat Vehicle expects to spend more than $1.9 billion in technology development. Increased funding of technology development can have beneficial effects for acquisition programs if the funds are spent on activities appropriate for that phase, such as prototype demonstrations and systems engineering analysis.

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 68 programs. For 48 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-seven of these 48 two-page assessments are of major defense acquisition programs, most of which are in development or early production; 5 assessments are of elements of MDA's BMDS; and 6 assessments are of programs that were projected to become major defense acquisition programs during or soon after our review. See figure 11 for an illustration of the layout of each two-page assessment. In addition, we produced one-page assessments on the current status of 20 programs, which include 14 future major defense acquisition programs, 2 major defense acquisition programs that are well into production, 1 element of MDA's BMDS, and 3 major defense acquisition programs that were recently terminated.

Figure 11: Illustration of Program Two-Page Assessment



Common Name: AGM-88E AARGM

AGM-88E Advanced Anti-Radiation Guided Missile (AARGM)

The Navy's AARGM is an air-to-ground missile for Navy and Marine Corps aircraft designed to destroy enemy radio-frequency-enabled surface-to-air defenses. The AARGM is an upgrade to the AGM-88 High Speed Anti-Radiation Missile (HARM). It will utilize the existing HARM rocket motor and warhead sections, a modified control section, and a new guidance section with Global Positioning System and improved targeting capabilities. The program is following a phased approach for development. We assessed phase I.

Source: U.S. Navy

Program Essentials

Prime contractor: ATK Missile Systems Company
Program office: Patuxent River, MD
Funding needed to complete:
R&D: $0.0 million
Procurement: $1319.6 million
Total funding: $1319.6 million
Procurement quantity: 1767

Program Performance (fiscal year 2012 dollars in millions)

	As of 07/2003	Latest 06/2011	Percent change
Research and development cost	$637.2	$722.2	13.4
Procurement cost	$963.6	$1180.0	22.5
Total program cost	$1,600.7	$1,902.3	18.8
Program unit cost	$.894	$.991	10.9
Total quantities	1790	1919	7.2
Acquisition cycle time (months)	85	104	22.4

The AARGM program entered production in September 2008 with its critical technologies mature and design stable, but without demonstrating its production processes were in control. The Navy halted operational testing in September 2010 after a series of missile failures caused by software issues and poor parts quality. The program reentered operational testing in August 2011 after Navy testers concluded that the anomalies identified during the program's first attempt at operational testing had been adequately addressed. Acceptance flight tests have screened out missiles of poor quality and validated recent improvements in the missile's reliability rate. However, concerns about the reliability and quality of the missiles being delivered are still being resolved.

Attainment of Product Knowledge

As of January 2012

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

Common Name: AGM-88E AARGM

AGM-88E AARGM Program

Technology and Design Maturity

The AARGM program's critical technologies are mature and its design is stable. According to the program office, AARGM's two critical technologies--the millimeter-wave software and radome--were mature when the program entered production in September 2008. However, according to reports from DOD's independent test organization--the Director, Operational Test and Evaluation (DOT&E)--in 2009 and 2010, millimeter-wave sensors continue to pose a risk to the missile's reliability. The number of expected design drawings has also continued to increase since the start of production, but the missile's design remains stable.

Production Maturity

The AARGM program's production processes were not mature when it entered production in September 2008 and the program has experienced quality problems that have resulted in test failures and reliability issues. According to the program office, the contractor has identified 18 critical manufacturing processes, 8 of which are currently in statistical control. The program plans to demonstrate that all 18 processes are in control during its second initial production run, which is scheduled for completion by the end of the second quarter of fiscal year 2012. Since entering production, the program has experienced multiple production delays and operational test failures. According to Defense Contract Management Agency (DCMA) and DOT&E officials, the test failures were caused by both hardware and software issues. The hardware failures involved multiple subcontractors and were primarily attributed to poor parts quality. According to a DCMA official, supplier assessments conducted in the aftermath of the program's test failures found several problems with the prime contractor's management of its suppliers. For example, not all program requirements had flowed down to the subcontractor level, nor had subcontractors received updated drawings as design changes were made.

According to DCMA officials, the program office and prime contractor have taken actions to address the quality issues; however, in July 2011, Navy test officials evaluating the program's readiness to reenter operational testing reported that the reliability of the missiles coming out of the factory had not improved. The Navy has implemented additional controls to identify missiles of poor quality, in particular, requiring each missile to be flight tested for 3 hours before accepting them. This testing detected early unreliable missiles and supports the effectiveness of subsequent quality improvements. However, additional flight testing will be necessary to fully verify these actions.

Other Program Issues

The AARGM program has experienced multiple test delays, which have delayed the planned delivery of initial operational capability until April 2012. The program began operational testing in June 2010 after a 9-month delay due in part to concerns from DOT&E about the production-representativeness of test missiles. The Navy decertified the program from operational testing in September 2010 after hardware and software issues caused a series of missile failures. The program conducted additional testing between November 2010 and June 2011 and received approval to reenter operational testing after program and testing officials concluded that the anomalies identified during the program's first attempt at operational testing had been adequately addressed.

Program Office Comments

In commenting on a draft of this assessment, the Navy noted that the AARGM program continues to pursue should cost initiatives, awarding low-rate production contracts within should cost targets for planned quantities. AARGM reentered integrated testing in coordination with DOT&E and Navy testers in January 2011 with rescreened production assets and new software. All previous anomalies were addressed. An operational test readiness review was conducted in July 2011 and operational flights began in August. Since January 2011, AARGM has flown more than 300 hours on five F-18 variants, was successfully shot seven times, and will obtain initial operational capability in the third quarter of fiscal year 2012. The Navy stated that reliability continues to improve and is now over twice the threshold requirement. The program has improved production processes, developing the necessary repeatability and quality to request a full-rate production decision in June 2012. The Navy also provided technical comments, which were incorporated as appropriate.

Ⓐ Program description

Ⓑ Illustration or photo of system

Ⓒ Schedule timeline identifying key dates for the program including the start of development, major design reviews, production decisions, and planned operational capability

Ⓓ **Program Essentials** Programmatic information including the prime contractor, program office location, and funding needed to complete

Ⓔ **Program Performance** Cost and schedule baseline estimates and the latest estimate provided as of January 2012

Ⓕ Brief summary describing the program's implementation of knowledge-based acquisition practices and its current status

Ⓖ **Attainment of Product Knowledge** Depiction of selected knowledge-based practices and the program's progress in attaining that knowledge

Ⓗ Assessment of program's technology, design, and production maturity, as well as other program issues

Ⓘ **Program Office Comments** General comments provided by the cognizant program office

Source: GAO analysis.

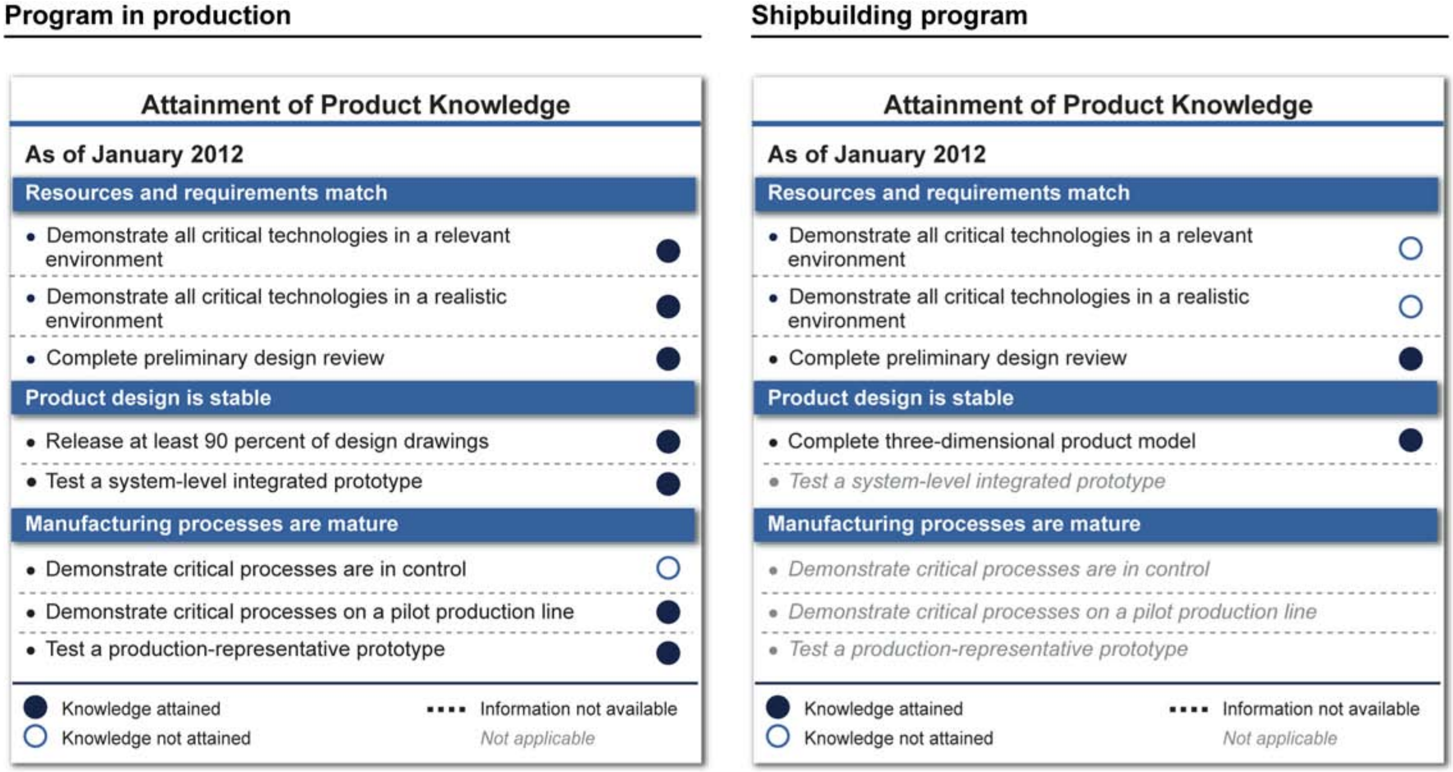
How to Read the Knowledge Scorecard for Each Program Assessed

For our two-page assessments, we depict the extent of knowledge gained in a program by 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 11 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 blue 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 either 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. See figure 12 for examples of the knowledge scorecards we use to assess these different types of programs.

Figure 12: Examples of Knowledge Scorecards



Program in production

Attainment of Product Knowledge

As of January 2012

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

Shipbuilding program

Attainment of Product Knowledge

As of January 2012

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*	

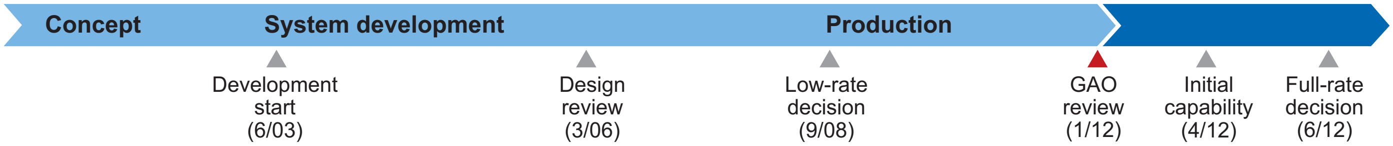
● Knowledge attained
○ Knowledge not attained
▪▪▪▪ Information not available
Not applicable

Source: GAO.

AGM-88E Advanced Anti-Radiation Guided Missile (AARGM)

The Navy's AARGM is an air-to-ground missile for Navy and Marine Corps aircraft designed to destroy enemy radio-frequency-enabled surface-to-air defenses. The AARGM is an upgrade to the AGM-88 High Speed Anti-Radiation Missile (HARM). It will utilize the existing HARM rocket motor and warhead sections, a modified control section, and a new guidance section with Global Positioning System and improved targeting capabilities. The program is following a phased approach for development. We assessed phase I.

Source: U.S. Navy.



Program Essentials

Prime contractor: ATK Missile Systems Company
Program office: Patuxent River, MD
Funding needed to complete:
  R&D: $0.0 million
  Procurement: $1,319.6 million
  Total funding: $1,319.6 million
  Procurement quantity: 1,767

Program Performance (fiscal year 2012 dollars in millions)

	As of 07/2003	Latest 06/2011	Percent change
Research and development cost	$637.2	$722.2	13.4
Procurement cost	$963.6	$1,180.0	22.5
Total program cost	$1,600.7	$1,902.3	18.8
Program unit cost	$.894	$.991	10.9
Total quantities	1,790	1,919	7.2
Acquisition cycle time (months)	85	104	22.4

The AARGM program entered production in September 2008 with its critical technologies mature and design stable, but without demonstrating its production processes were in control. The Navy halted operational testing in September 2010 after a series of missile failures caused by software issues and poor parts quality. The program reentered operational testing in August 2011 after Navy testers concluded that the anomalies identified during the program's first attempt at operational testing had been adequately addressed. Acceptance flight tests have screened out missiles of poor quality and validated recent improvements in the missile's reliability rate. However, concerns about the reliability and quality of the missiles being delivered are still being resolved.

Attainment of Product Knowledge

As of January 2012

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

AGM-88E AARGM Program

Technology and Design Maturity

The AARGM program's critical technologies are mature and its design is stable. According to the program office, AARGM's two critical technologies—the millimeter-wave software and radome—were mature when the program entered production in September 2008. However, according to reports from DOD's independent test organization—the Director, Operational Test and Evaluation (DOT&E)—in 2009 and 2010, millimeter-wave sensors continue to pose a risk to the missile's reliability. The number of expected design drawings has also continued to increase since the start of production, but the missile's design remains stable.

Production Maturity

The AARGM program's production processes were not mature when it entered production in September 2008 and the program has experienced quality problems that have resulted in test failures and reliability issues. According to the program office, the contractor has identified 18 critical manufacturing processes, 8 of which are currently in statistical control. The program plans to demonstrate that all 18 processes are in control during its second initial production run, which is scheduled for completion by the end of the fourth quarter of fiscal year 2012. Since entering production, the program has experienced multiple production delays and operational test failures. According to Defense Contract Management Agency (DCMA) and DOT&E officials, the test failures were caused by both hardware and software issues. The hardware failures involved multiple subcontractors and were primarily attributed to poor parts quality. According to a DCMA official, supplier assessments conducted in the aftermath of the program's test failures found several problems with the prime contractor's management of its suppliers. For example, not all program requirements had flowed down to the subcontractor level, nor had subcontractors received updated drawings as design changes were made.

According to DCMA officials, the program office and prime contractor have taken actions to address the quality issues; however, in July 2011, Navy test officials evaluating the program's readiness to reenter operational testing reported that the reliability of the missiles coming out of the factory had not improved. The Navy has implemented additional controls to identify missiles of poor quality, in particular, requiring each missile to be flight tested for 3 hours before accepting them. This testing detected early unreliable missiles and supports the effectiveness of subsequent quality improvements. However, additional flight testing will be necessary to fully verify these actions.

Other Program Issues

The AARGM program has experienced multiple test delays, which have delayed the planned delivery of initial operational capability until April 2012. The program began operational testing in June 2010 after a 9-month delay due in part to concerns from DOT&E about the production-representativeness of test missiles. The Navy decertified the program from operational testing in September 2010 after hardware and software issues caused a series of missile failures. The program conducted additional testing between November 2010 and June 2011 and received approval to reenter operational testing in August 2011 after program and testing officials concluded that the anomalies identified during the program's first attempt at operational testing had been adequately addressed.

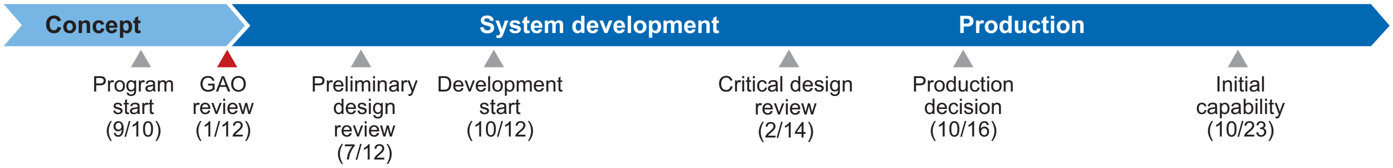
Program Office Comments

In commenting on a draft of this assessment, the Navy noted that the AARGM program continues to pursue should cost initiatives, awarding low-rate production contracts within should cost targets for planned quantities. AARGM reentered integrated testing in coordination with DOT&E and Navy testers in January 2011 with rescreened production assets and new software. All previous anomalies were addressed. An operational test readiness review was conducted in July 2011 and operational flights began in August. Since January 2011, AARGM has flown more than 300 hours on five F-18 variants, was successfully shot seven times, and will obtain initial operational capability in the third quarter of fiscal year 2012. The Navy stated that reliability continues to improve and is now over twice the threshold requirement. The program has improved production processes, developing the necessary repeatability and quality to request a full-rate production decision in June 2012. The Navy also provided technical comments, which were incorporated as appropriate.

Air and Missile Defense Radar (AMDR)

The Navy's Air and Missile Defense Radar (AMDR) will be 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 defense and air defense, 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 the foundation for a scalable radar architecture that can be used to defeat advanced threats.

Source: U.S. Navy.



Program Essentials

Prime contractor: Lockheed Martin, Northrop Grumman, Raytheon
Program office: Washington, DC
Funding needed to complete:
R&D: $1,584.7 million
Procurement: $13,597.2 million
Total funding: $15,181.9 million
Procurement quantity: 24

Program Performance (fiscal year 2012 dollars in millions)

	As of	Latest 09/2011	Percent change
Research and development cost	NA	$2,211.8	NA
Procurement cost	NA	$13,597.3	NA
Total program cost	NA	$15,837.3	NA
Program unit cost	NA	$659.887	NA
Total quantities	NA	24	NA
Acquisition cycle time (months)	NA	149	NA

AMDR plans to enter system development in October 2012 with some of the recommended knowledge about its technology and requirements. According to the Navy, AMDR's six critical technologies are expected to be demonstrated in a relevant environment before the start of system development. The program also plans to conduct a preliminary design review to refine its requirements. In September 2010, the Navy selected three contractors to build and test prototypes to demonstrate AMDR's critical technologies. Program officials stated that digital beamforming technology, which is necessary for simultaneous air and ballistic missile defense, will likely take the longest to mature. The Navy and shipbuilders have determined that a 14-foot active radar is the largest that can be accommodated by the existing DDG 51. AMDR is also being developed to be scaled up in size.

Attainment of Product Knowledge

Projected as of January 2012

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 Maturity

According to the Navy, all six critical technologies for the AMDR program are expected to be nearing maturity and demonstrated in a relevant environment before a decision is made to enter system development. They are currently immature. Program officials stated that digital beamforming technology—necessary for AMDR's simultaneous air and ballistic missile defense mission—has been identified as the most significant challenge and will likely take the longest time to mature. Digital beamforming enables the radar to generate and process multiple beams simultaneously, which results in more radar resources being available to support simultaneous air and missile defense. Program officials stated that this technology has been used before, but it has never been demonstrated in a radar as large as AMDR.

The AMDR's transmit-receive modules—the individual radiating elements key to transmitting and receiving electromagnetic signals—also pose a challenge. According to the program office, similar radar programs have experienced significant problems developing transmit-receive modules, resulting in cost and schedule growth. To achieve the increased performance levels required for AMDR, the contractor will likely use gallium nitride semiconductor technology instead of the legacy gallium arsenide technology. The new technology has the potential to provide higher power and efficiency with a smaller footprint. According to the Navy, this would reduce the power and cooling demands placed on the ship by the radar. However, gallium nitride has never been used in a radar as large as the AMDR, and long-term reliability and performance of this newer material is unknown. If these transmit-receive units cannot provide the required power, the program would either need to use the legacy technology and increase the power and cooling resources available for the AMDR, or accept reduced power and performance for the AMDR S-band radar.

Other Program Issues

The AMDR program entered technology development in September 2010 and the Navy awarded fixed-price incentive fee contracts to Northrop Grumman, Lockheed Martin, and Raytheon for S-band radar and radar-suite controller technology development. The contractors will build and test prototypes to demonstrate all critical technologies during a 2-year technology development period. The X-band portion of AMDR will be based on existing technology that is already mature. Additional software development will be required to integrate the two radars.

The Navy plans to install AMDR on Flight III DDG 51s starting in 2019. The Navy has yet to determine the size of AMDR for Flight III. According to draft AMDR documents, a 14-foot radar is needed to meet requirements, but an over-20-foot radar is needed to fully meet the Navy's desired integrated air and missile defense capabilities. However, the shipyards and the Navy have determined that a 14-foot active radar is the largest that can be accommodated within the confines of the existing DDG 51 deckhouse, even though AMDR is being built with the capability to be scaled up in size to meet future threats.

Program Office Comments

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

Apache Block IIIA (AB3A)

The Army's Apache Block IIIA (AB3A) program is upgrading AH-64D Longbow helicopters to improve performance, situational awareness, lethality, survivability, and interoperability, and to prevent friendly fire incidents. It consists of three sets of upgrades. For the first set of upgrades, AH-64Ds are sent to the factory for hardware changes. The second and third sets of upgrades are primarily software-related and can be installed in the field, reducing the time an aircraft is out of service and increasing training time for soldiers.

Source: U.S. Army.

Program Essentials

Prime contractor: Boeing
Program office: Huntsville, AL
Funding needed to complete:
  R&D: $706.8 million
  Procurement: $8,363.7 million
  Total funding: $9,070.6 million
  Procurement quantity: 610

Program Performance (fiscal year 2012 dollars in millions)

	As of 08/2006	Latest 12/2010	Percent change
Research and development cost	$1,155.6	$1,640.3	41.9
Procurement cost	$6,086.9	$9,096.8	49.4
Total program cost	$7,242.5	$10,737.0	48.3
Program unit cost	$12.031	$16.803	39.7
Total quantities	602	639	6.1
Acquisition cycle time (months)	79	82	3.8

The latest cost and quantities do not include the 57 new-build helicopters that are being acquired under the AB3B major defense acquisition program.

The AB3A program began production in October 2010 with mature critical technologies, a stable design, and manufacturing processes that had been demonstrated, but were not in control. The program is required to demonstrate its processes are in control prior to entering full-rate production. The program has begun installing the first of three sets of upgrades on AH-64Ds, and according to the program office, upgraded aircraft are on schedule to begin operational testing in March 2012. The design reviews for the second and third set of upgrades are planned for 2013 and 2015, respectively. These upgrades will be installed in the 2015 to 2017 time frame. In 2010, AB3 was restructured into two programs—AB3A for remanufactured aircraft and AB3B for new-build aircraft. New-build aircraft will be identical to the remanufactured ones and begin delivery in 2014.

Attainment of Product Knowledge

As of January 2012

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

AB3A Remanufacture Program

Technology and Design Maturity

The AB3A program's one critical technology is mature and the design for the first set of upgrades is stable. The program has begun installing the first set of upgrades on AH-64D aircraft and the first upgraded aircraft entered service in October 2011. The development effort for the second and third set of upgrades, which are primarily software-related, is on track to begin in early 2012. According to the program office, these upgrades focus on reducing pilot and maintainer workload; expanding interoperability, survivability, and manned-unmanned teaming capabilities with other aircraft; improving targeting and navigation; and establishing the architecture for the integration of future technologies. According to the program office, the software development effort was preliminarily estimated at approximately 370,000 lines of code and this estimate was used to support the program's updated cost estimate for its production decision. Design reviews for these sets of upgrades are scheduled for 2013 and 2015, respectively, with follow-on operational testing planned for fiscal years 2014 and 2015.

Production Maturity

The AB3A program began production in October 2010 with manufacturing processes that had been demonstrated on a pilot production line, but were not in control. Prior to the production decision, the program concluded that its manufacturing readiness was at the level recommended by DOD guidance for the start of low-rate production. However, the program's manufacturing readiness level did not indicate that its production processes were in statistical control. The program is currently in the process of reassessing its manufacturing readiness. Before its planned July 2012 full-rate production decision, the program must successfully complete initial operational test and evaluation and meet other DOD criteria, which include demonstrating its processes are stable, in control, and meet acceptable process capability levels. AB3A has completed the first of three operational test readiness reviews and plans to hold the second and third reviews shortly before initial operational test and evaluation is planned to begin in March 2012. According to program officials, the AB3A is also on track to meet DOD criteria related to its performance, reliability, supportability, and manufacturing capability.

Other Program Issues

In 2010, following a Nunn-McCurdy unit-cost breach of the critical threshold, AB3 was restructured into two major defense acquisition programs—AB3A for remanufactured aircraft and AB3B for new-build aircraft. The original AB3 program involved taking legacy aircraft and remanufacturing them with upgraded capabilities. However, decreases in the numbers of legacy aircraft available for remanufacture, combined with increasing wartime demands, resulted in the addition of 57 new-build aircraft. The programs were separated to provide visibility into the cost, schedule, and performance of each segment. Structurally and technologically, the remanufactures and new-builds will be identical and the programs will share a common contract. New-build aircraft will cost significantly more than the remanufactured aircraft because of the need to procure all new parts. According to program officials, the production line for AH-64Ds did not have to be restarted for the AB3B program because it has been kept active for wartime replacements. The program expects to deliver the first new-build aircraft in fiscal year 2014. Foreign military sales have the potential to reduce the unit cost of the AB3A and AB3B. In 2012, the program will begin delivering foreign military sale aircraft to Taiwan, and several other countries are prospective buyers as well.

Program Office Comments

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

Army Integrated Air and Missile Defense (Army 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 (IBCS) will provide a capability to control and manage IAMD sensors and weapons, such as the Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System and Patriot, 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.
Program office: Huntsville, AL
Funding needed to complete:
R&D: $1,370.5 million
Procurement: $3,509.0 million
Total funding: $4,879.5 million
Procurement quantity: 285

Program Performance (fiscal year 2012 dollars in millions)

	As of 12/2009	Latest 08/2011	Percent change
Research and development cost	$1,595.2	$2,019.8	26.6
Procurement cost	$3,433.4	$3,509.0	2.2
Total program cost	$5,028.6	$5,528.8	9.9
Program unit cost	$16.988	$18.678	9.9
Total quantities	296	296	0.0
Acquisition cycle time (months)	80	81	1.3

IAMD's mission has not changed, but changes to its plans for integrating other systems have significantly increased the size of its software effort, delayed its design review by 8 months, and increased its development costs by over $400 million. These changes include adding Patriot launcher and radar functionality directly onto the integrated fire control network and increasing IBCS quantities. WIN-T integration is also a significant risk. The program is projecting that its design will be stable at its planned April 2012 design review, but it does not plan to demonstrate the design can perform as expected until August 2013. Additional cost increases may occur because the Army may increase the number of IBCS units it plans to buy. According to officials, DOD is expected to direct a new independent cost estimate and an updated program baseline.

Attainment of Product Knowledge

As of January 2012

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

The IAMD program entered system development in December 2009 with its four critical technologies—integrated battle command, integrated defense design, integrated fire control network, and distributed track management—nearing maturity, according to an Army technology readiness assessment based on a notional design. The Army updated the technology readiness assessment in March 2011 based on the winning contractor's design and reached the same conclusion about the technologies' maturity. The Office of the Assistant Secretary of Defense for Research and Engineering concurred with the assessment, but noted that integration with the Warfighter Information Network–Tactical (WIN-T) is a significant risk. It also noted that the assessment was based on modeling and simulations of the WIN-T and assumptions about performance. As a result, it recommended realistic, full-scale testing with WIN-T prior to a production decision. Program officials estimate that IAMD technologies will not be fully mature until its planned production decision in 2015.

Design Maturity

The IAMD program plans to release over 90 percent of its total expected drawings by its design review, but it does not plan to demonstrate that the design can perform as expected until August 2013—over a year later. As a result, the risk of design changes will remain. The IAMD design review has been delayed by 8 months to April 2012, in part because the program has made significant changes to the way it intends to integrate its planned engagement capabilities. These changes include adding Patriot launcher and radar functionality directly onto the IAMD integrated fire control network. The Medium Extended Air Defense System and Surface-Launched Advanced Medium-Range Air-to-Air Missile are no longer planned to be integrated with the system because those programs have been sharply curtailed or cancelled.

Other Program Issues

IAMD's development costs have risen by over $400 million or about 27 percent since development start and may increase further. According to program officials, the increases are primarily attributable to the decision to incorporate Patriot launcher and sensor functionality into the integrated fire control network and add a command and control module. According to program officials, increasing the number of IBCS units will provide for a common command and control at all echelons. Program officials now estimate the size of the software development at over 6.6 million lines of code—a 37 percent increase over the estimate at development start. In addition, about 63 percent will be newly developed code or auto-generated code. The cost of the added software has not yet been finalized, but program officials estimate that it will add 6 months to the software development effort. Other anticipated changes to the IAMD system, including an increase to the number of IBCS units, could increase costs further. According to program officials, DOD is expected to direct a new independent cost estimate for the program and an updated program baseline.

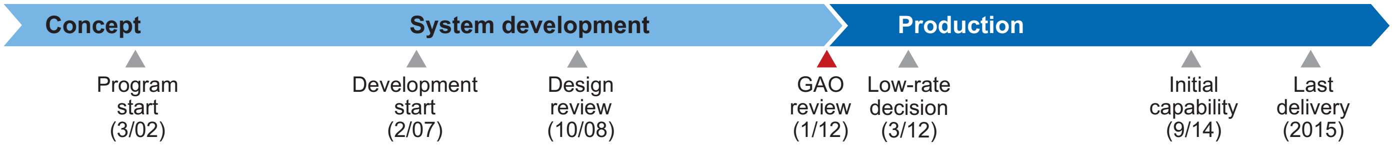
Program Office Comments

In commenting on a draft of this assessment, the program office noted that increases to the program include funds provided to add the Patriot sensor and launcher directly onto the integrated fire control network and IBCS units to provide full IAMD functionality at all echelons. The program is on schedule to conduct the design review in April 2012. Program delay is partially due to a reduction of $45 million shortly following the system development decision and the fiscal year 2011 continuing resolution. The Army IAMD program at development start was based on a generic design due to the competitive prototyping efforts of the contractors, and the originally estimated software lines of code were not specific to either contractor's approach. Since contract award, the contractor refined the estimates and software size should be stable going forward. To state that the software lines of code have grown 37 percent since development start is not wholly accurate since much of the increase is attributable to auto-generated code which requires less effort to complete. The program also provided technical comments, which were incorporated as appropriate.

B-2 Extremely High Frequency SATCOM Capability, Increment 1

The Air Force's B-2 EHF SATCOM Increment 1 program will upgrade the aircraft's flight-management computer processors, increase data-storage capacity, and establish a high-speed network that will serve as the foundation for future B-2 upgrades, such as those being developed by the B-2 EHF SATCOM Increment 2 and the Defensive Management System Modernization programs. The development and successful integration of new disk-drive units and integrated-processing units is a primary objective for Increment 1.

Source: U.S. Air Force.



Program Essentials

Prime contractor: Northrop Grumman
Program office: Wright-Patterson AFB, OH
Funding needed to complete:
  R&D: $62.6 million
  Procurement: $127.4 million
  Total funding: $190.1 million
  Procurement quantity: 16

Program Performance (fiscal year 2012 dollars in millions)

	As of 05/2007	Latest 08/2011	Percent change
Research and development cost	$586.4	$497.7	-15.1
Procurement cost	$123.5	$127.4	3.1
Total program cost	$710.0	$625.2	-11.9
Program unit cost	$33.808	$31.258	-7.5
Total quantities	21	20	-4.8
Acquisition cycle time (months)	85	91	7.1

The B-2 EHF SATCOM Increment 1 program is expected to enter production in March 2012 with mature critical technologies and a stable design, but without fully demonstrating its production processes. A September 2011 operational assessment report indicated that Increment 1 is on track to meet system requirements; however, some software-related deficiencies must be resolved prior to initial operational test and evaluation in 2012. The program completed a production readiness review in May 2011, and expects to demonstrate sufficient manufacturing readiness prior to production. However, the program does not intend to demonstrate its critical manufacturing process is in control before starting production. According to the program office, it has demonstrated the capability to produce key components in a production-representative environment and established reliability through lab testing.

Attainment of Product Knowledge

As of January 2012

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

B-2 EHF SATCOM Increment 1 Program

Technology and Design Maturity

All six B-2 EHF SATCOM Increment 1 critical technologies are mature and its design is stable. In February 2007, the program entered system development with all of its critical technologies nearing maturity. Since that time, these technologies have been matured and flight-qualified. The program office has reported that its design has been stable since its October 2008 critical design review. All expected drawings were releasable at that time and there has been no increase in the number of drawings since then. A September 2011 operational assessment report by the Air Force Test and Evaluation Center found that Increment 1 is on track to meet its effectiveness, suitability, and mission capability requirements; however, there are some software-driven shortfalls that need to be addressed prior to initial operational test and evaluation in 2012. In particular, the assessment report cited software deficiencies related to the system's communications capabilities and aircrew workload as critical issues requiring attention.

Production Maturity

The B-2 EHF SATCOM Increment 1 program is expected to enter production in March 2012 without fully demonstrating its production processes. The program completed a production readiness review in May 2011 and has identified one critical manufacturing process. According to the program office, by the start of production, manufacturing readiness will be at a level consistent with what is recommended in DOD manufacturing readiness level guidance. However, the program does not expect to demonstrate that its critical manufacturing process is in control—meaning that it meets our standards for production defect rates—before its production decision. In addition, the program will not be demonstrating manufacturing processes on a pilot line, but has employed alternative measures to demonstrate production maturity. For example, the program has demonstrated the capability to produce targeted components—disk-drive units, integrated-processing units, and a fiber harness—in a production-representative environment. According to program officials, they have also established that the integrated-processing and disk-drive units have high levels of reliability using data from lab testing.

Other Program Issues

The B-2 EHF SATCOM Increment 1 has been largely able to overcome early delays in its test program. The program completed software certification in April 2010, flight testing began in September 2010, and the completion of initial operational test and evaluation is expected by late fiscal year 2012. The health of the test aircraft has continued to be a challenge for meeting the test schedule. Nevertheless, the program's planned software release to flight test in late fiscal year 2011 was completed and an operational assessment found the system to be on track to achieve its planned mission capability.

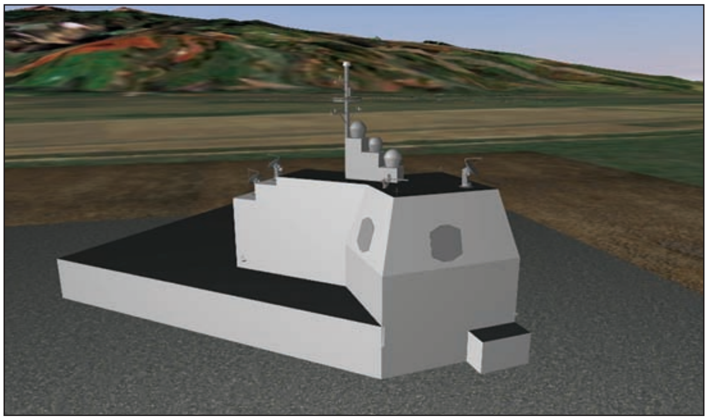
According to the program office, the B-2 EHF Increment 1 production decision was postponed from October 2011 to March 2012 to allow the negotiated contract price and the program's production cost estimate to be reconciled. The program has received Air Force approval to speed up production by pursuing a firm fixed-price two-lot buy instead of the previously planned three-lot buy, which should reduce production costs and provide for an earlier full operational capability.

Program Office Comments

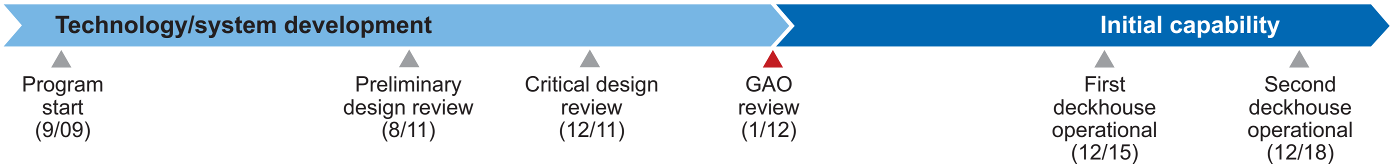
In commenting on a draft of this assessment, the B-2 EHF Increment 1 program office stated that in addition to the program reaching a sufficient manufacturing readiness level prior to the start of low-rate initial production, the program plans to conduct an additional manufacturing readiness assessment during the initial phase of production in summer 2012 to demonstrate achievement of further maturity prior to the full-rate production decision planned for December 2012.

BMDS: Aegis Ashore

MDA's Aegis Ashore is a planned land-based variant of the ship-based Aegis Ballistic Missile Defense system. It will track and intercept ballistic missiles using a vertical launching system, variants of the Standard Missile-3 (SM-3), and enclosures called deckhouses that contain a SPY-1 radar and command and control system. We assessed Aegis Ashore with SM-3 Block IB. DOD plans to first deploy this configuration in a host nation in the 2015 time frame as part of the European Phased Adaptive Approach Phase II.



Source: Missile Defense Agency.



Program Essentials

Prime contractor: Multiple
Program office: Dahlgren, VA
Funding needed to complete:
  R&D: TBD
  Procurement: TBD
  Total funding: TBD
  Procurement quantity: TBD

Program Performance (fiscal year 2012 dollars in millions)

	As of 04/2010	Latest 03/2011	Percent change
Research and development cost	$835.1	$1,418.6	69.9
Procurement cost	NA	NA	NA
Total program cost	$835.1	$1,418.6	69.9
Program unit cost	$417.565	$472.864	13.2
Total quantities	2	3	50.0
Acquisition cycle time (months)	NA	NA	NA

Estimates in table above do not include missile costs.

Aegis Ashore is following a concurrent acquisition approach by entering system development prior to holding a preliminary design review and purchasing operational components prior to completing testing—both of which increase the risk of cost growth and schedule delays. The program office has now assessed its five critical technologies as mature or nearing maturity. However, several of these technologies may be less mature than reported. The system's design was stable by February 2012, but the risk of design changes will remain until it demonstrates the design can perform as expected by flight testing, which will not occur until 2014. Program management stated that the development is low risk because the technologies are already used by Aegis BMD ships and the program's ground and flight test schedule will confirm the capability by the time it is deployed.

Attainment of Product Knowledge

As of January 2012

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

BMDS: Aegis Ashore Program

Technology Maturity

According to the Aegis Ashore program office, all five of its critical technologies are mature or nearing maturity. The program has assessed the SPY-1 radar, command and control system, SM-3 Block IB interceptor, and vertical launching system as mature and the multimission signal processor as nearing maturity. However, the maturity of some of these technologies may be overstated. The SPY-1 radar requires modifications for its use on land and other changes may be necessary due to host nation radar frequency issues. Program management officials stated at least some of these changes are software modifications, but the frequency issues may require other changes. The launch system must also be modified for use both on land and at a greater distance from the deckhouse. In addition, the maturity of SM-3 Block IB may be overstated because some of its component technologies have not been flight tested or have experienced failures in testing. The multimission signal processor also faces development challenges, and the Defense Contract Management Agency has identified its schedule as high risk. We have previously reported that a significant percentage of its software still needs to be integrated.

Design Maturity

The deckhouse design was 100 percent complete in February 2012, prior to the planned award of the deckhouse fabrication contract in the third quarter of fiscal year 2012. However, the program does not plan to demonstrate the design can perform as expected by flight testing until 2014, although there will be ground testing to demonstrate Aegis Ashore component integration prior to the flight test. As a result, the risk of design changes will remain until developmental testing is complete.

Other Program Issues

The Aegis Ashore program is following an acquisition approach that increases the risk of cost growth and schedule delays. The program began system development 14 months before completing its preliminary design review. We have previously reported that this review should be held prior to starting development to ensure that requirements are defined, feasible, and achievable within cost, schedule, and other system constraints. The program also contains concurrency between development and production, which increases the risk of late and costly design changes and retrofits. For example, the program is simultaneously acquiring the developmental test deckhouse and the operational deckhouse and is constructing the operational deckhouse first. In addition, the first developmental flight test of Aegis Ashore is scheduled for the second quarter of fiscal year 2014, at which point two deckhouses will have been constructed and other components will already be in production. Program management officials stated its concurrent schedule is low risk given its use of technology already used by Aegis BMD and modifications can be made to the deckhouse before it is installed in Romania. In addition, it stated that the current strategy has cost benefits and construction and testing efficiency advantages.

The program has experienced cost growth because of additional requirement costs. In 2011, the unit cost of Aegis Ashore grew, which the program attributed to costs for the reconstitutable deckhouse design that were not included in its baseline and the addition of hardware for a third site in Poland.

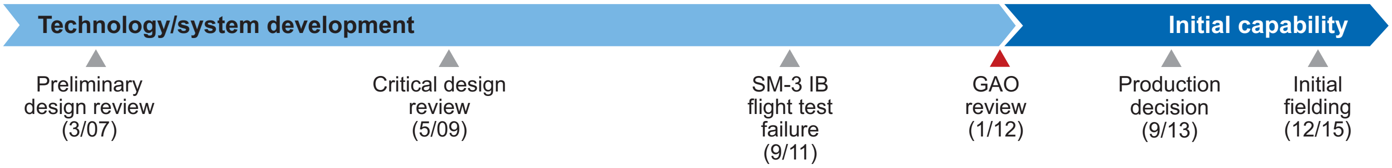
Program Office Comments

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

BMDS: Aegis Ballistic Missile Defense Standard Missile-3 Block IB

MDA's Aegis Ballistic Missile Defense is a sea- and land-based system being developed to defend against ballistic missiles of all ranges. It includes a radar, battle management and command and control systems, and Standard Missile-3 (SM-3) missiles. We reviewed the SM-3 Block IB (SM-3 IB), which will feature an improved target seeker, an advanced signal processor, and an improved divert/attitude control system for adjusting its course. It is planned to be fielded in the 2015 time frame as part of European Phased Adaptive Approach Phase II.

Source: Missile Defense Agency.



Program Essentials

Prime contractor: Raytheon
Program office: Dahlgren, VA
Funding FY12 to FY16:
  R&D: $250.7 million
  Procurement: $3,330.1 million
  Total funding: $3,580.8 million
  Procurement quantity: TBD

Program Performance (fiscal year 2012 dollars in millions)

	As of	Latest 05/2011	Percent change
Research and development cost	NA	$676.6	NA
Procurement cost	NA	$3,330.1	NA
Total program cost	NA	$4,006.7	NA
Program unit cost	NA	NA	NA
Total quantities	NA	370	NA
Acquisition cycle time (months)	NA	NA	NA

Costs are from program inception through fiscal year 2016.

The SM-3 IB will be at continued risk of cost growth, schedule delays, and performance shortfalls unless it demonstrates that the missile's critical technologies and design perform as expected before committing to further production. In 2011, the SM-3 IB failed during its first developmental flight test. At the time of the failure, MDA had contracted for 25 SM-3 IB interceptors, 18 of which were dedicated to flight testing. As a result of the flight test failure, MDA halted acceptance of SM-3 IB deliveries, convened a failure review board, and delayed key program decisions. In addition, two critical technologies—the throttleable divert attitude control system and third-stage rocket motor—still may not be mature. The attitude control system has not completed developmental testing or been successfully flight tested and the third-stage rocket motor may need to be redesigned.

Attainment of Product Knowledge

As of January 2012

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

BMDS: SM-3 Block IB Program

Aegis BMD Element - Block 2004

According to the program, all five of its critical technologies—the third-stage rocket motor, throttleable divert attitude control system, reflective optics, two-color warhead seeker, and kinetic warhead advanced signal processor—are mature. However, the attitude control system has not completed qualification testing or been demonstrated in a realistic flight environment. In addition, the third-stage rocket motor, which was previously considered the most mature technology, may need to be redesigned to address issues discovered in flight testing. In its first developmental flight test in September 2011, the SM-3 IB experienced a failure involving one of its critical technologies and did not intercept the target. A failure review board is investigating the cause. The program plans to redo the failed test and conduct two additional intercept flight tests in 2012. Program officials expect that all SM-3 IB technologies will be flight-qualified and demonstrated through testing by the program's planned fiscal year 2013 production decision.

Design Maturity

The SM-3 IB's design has been relatively stable since its critical design review in May 2009, although design changes may be necessary to address issues discovered in testing. In addition, the program has not demonstrated that the missile's design can perform as intended through developmental testing. As a result, it remains at risk for further design changes, cost growth, and schedule delays.

Production Maturity

MDA has delayed the official start of operational missile production from February 2010 to the fourth quarter of fiscal year 2013. According to officials, MDA will not make this production decision until it completes initial developmental testing with production-representative missiles and shipboard systems.

The program has already contracted for 25 missiles, 18 of which will be used for developmental testing. The seven additional missiles could require costly rework and retrofits if the program decides to use them as operational assets as planned. According to MDA, additional missiles will also be used to prove manufacturing processes and for other purposes. MDA is also planning to purchase 46 additional missiles in fiscal year 2012. Any additional missiles ordered in fiscal year 2012 before the completion of flight tests needed to validate the missile's performance would be at higher risk of cost growth and schedule delays.

The flight-test failure investigation and possible redesigns are delaying both developmental and operational missile production. The program's acceptance of developmental missile deliveries and the production of certain missile components are on hold pending the results of the investigations. Program officials estimate that the failure investigations, design modifications, and additional testing will increase costs and they have not yet determined how many missiles may need to be refurbished.

Other Program Issues

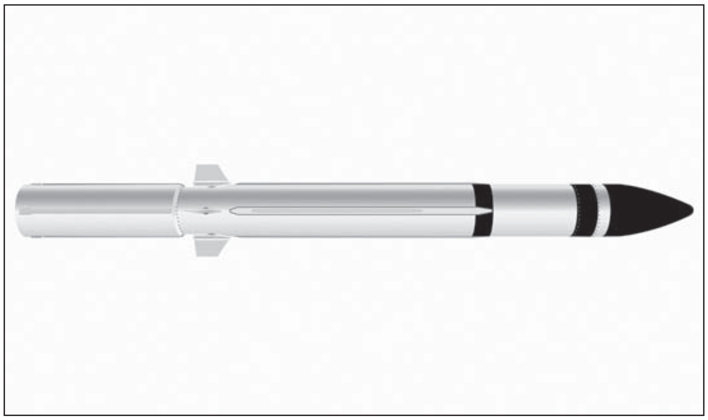
MDA originally planned to stop production of the SM-3 IA in 2010 and begin production of the SM-3 IB. However, SM-3 IB developmental issues have required MDA to twice delay the purchase of SM-3 IB missiles, purchase additional SM-3 IA missiles to avoid production gaps and keep SM-3 suppliers active, and reduce the planned initial purchase quantity of SM-3 IBs. The program's acceptance of SM-3 IA deliveries and the production of a missile component have been halted since April 2011, when an SM-3 IA missile experienced an anomaly during a flight test. The anomaly may have occurred in a component that is common to the SM-3 IA and SM-3 IB.

Program Office Comments

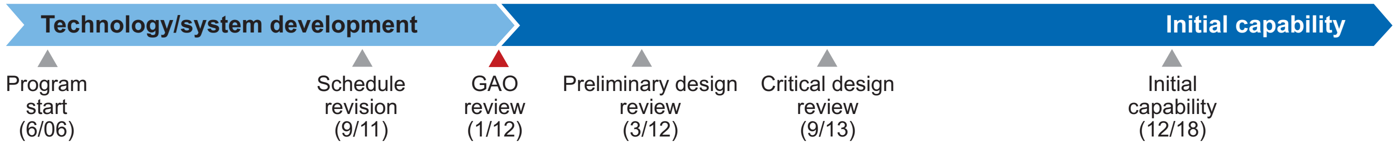
In commenting on a draft of this assessment, MDA provided technical comments, which were incorporated as appropriate.

BMDS: Aegis Ballistic Missile Defense Standard Missile-3 Block IIA

MDA's Aegis Ballistic Missile Defense (BMD) is a sea- and land-based system being developed to defend against missiles of all ranges. It includes a radar, command and control systems, and Standard Missile-3 (SM-3) missiles. We reviewed the SM-3 Block IIA, a cooperative development with Japan, which will have increased velocity and range, a more sensitive seeker, and a more advanced warhead than other SM-3 variants. It is to be fielded with Aegis Weapons System 5.1 in the 2018 time frame as part of the European Phased Adaptive Approach.



Source: Missile Defense Agency.



Program Essentials

Prime contractor: Lockheed Martin, Raytheon
Program office: Dahlgren, VA
Funding needed to complete:
  R&D: TBD
  Procurement: TBD
  Total funding: TBD
  Procurement quantity: TBD

Program Performance (fiscal year 2012 dollars in millions)

	As of 04/2010	Latest 05/2011	Percent change
Research and development cost	$2,062.7	$2,521.8	22.3
Procurement cost	NA	NA	NA
Total program cost	$2,062.7	$2,521.8	22.3
Program unit cost	NA	NA	NA
Total quantities	NA	NA	NA
Acquisition cycle time (months)	NA	NA	NA

The cost includes funding for Aegis Weapon System upgrades that will be fielded with the missile.

The SM-3 Block IIA program faces significant technology development challenges. Six of the program's eight critical technologies are immature and require additional development and testing before they can be demonstrated in a system prototype. In addition, four key components failed to complete their subsystem preliminary design reviews in fiscal year 2011, prompting a rebalancing of requirements, the substitution of some components, and an overhaul of the development schedule. Some of the program's critical technologies will need to be modified to address issues found during these reviews. The revised program schedule adjusted system-level design reviews and added more time for development. This will increase program costs, but it also has the potential to reduce acquisition risk and future cost growth and schedule delays.

Attainment of Product Knowledge

As of January 2012

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

BMDS: SM-3 Block IIA Program

Technology Maturity

The SM-3 Block IIA program faces significant technology development challenges. The majority of the SM-3 Block IIA components are new technology compared to the SM-3 Block IB. The program must develop a new propulsion system with a much greater thrust, a new divert and attitude control system, a more capable seeker, and use new solid fuel, all of which pose significant technological challenges. The development of similar components has been a challenge for previous SM-3 interceptors.

The SM-3 Block IIA program has identified eight critical technologies—six of which are immature and require additional development and testing before they can be demonstrated in a system prototype. The program held subsystem preliminary design reviews during fiscal year 2011, which demonstrated that some critical technologies required redesign or other adjustments. The program has plans in place to rebalance SM-3 Block IIA requirements or replace certain technology components. For example, the program has moved away from a component that has caused problems for the SM-3 Block IB. The program completed new reviews for the four technologies that failed to complete the initial reviews by early fiscal year 2012. In addition, two critical technologies—the second- and third-stage rocket motors—have experienced problems during testing. The program was investigating the causes of those problems and the potential effects at the end of fiscal year 2011. According to the program, all critical technologies will be nearing maturity by its planned September 2013 critical design review.

Other Program Issues

The SM-3 Block IIA program has extended its development schedule by more than a year, which likely will increase program costs, but lower the risk of further cost growth and schedule delays in the future. The program adjusted its system-level preliminary and critical design reviews after several key components failed their preliminary design reviews. The adjustment may reduce acquisition risk and the potential for future cost growth by providing the program more time to reconcile gaps between requirements and resources; demonstrate technical knowledge; and ensure that requirements are defined, feasible, and achievable before committing to product development. The new schedule also lowers risk in other ways, such as building in more recovery time between program reviews and flight tests. Under the revised schedule, flight tests will be delayed from 2015 to late 2016. The SM-3 Block IIA is still planned to be deployed with Aegis Weapons System 5.1 as part of the European Phased Adaptive Approach Phase III in the 2018 time frame.

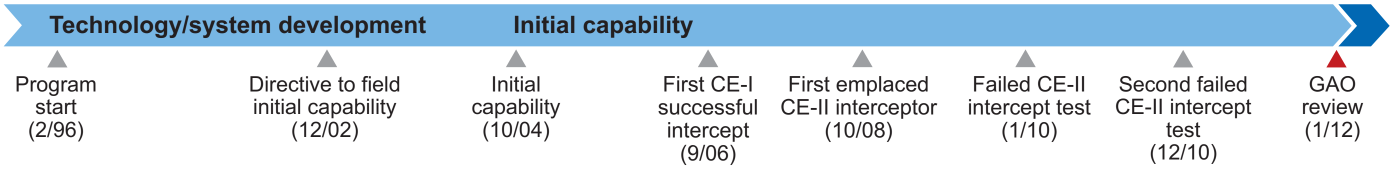
Program Office Comments

In commenting on a draft of this assessment, Aegis BMD program management officials noted the SM-3 Block IIA program held 60 component-level preliminary design reviews in fiscal year 2011, of which 4 did not receive a pass during the first evaluation. This result drove a schedule adjustment of 1 year. The officials further noted the program used this additional time to implement a more robust engineering process. Actions the program took resulted in the completion of the four component-level reviews and support the completion of the system-level preliminary design review in March 2012. The rebalancing of the component-level requirements that occurred has not affected system-level requirements. Finally, the officials note that the program is on schedule to achieve its European Phased Adaptive Approach objectives. MDA also provided technical comments, which were incorporated as appropriate.

BMDS: Ground-Based Midcourse Defense (GMD)

MDA's GMD is being fielded to defend against limited long-range ballistic missile attacks during their midcourse phase. GMD consists of an interceptor with a 3-stage booster and kill vehicle and a fire control system, which formulates battle plans and directs components that are integrated with BMDS radars. We assessed the maturity of all GMD critical technologies and the design of the Capability Enhancement II (CE-II) configuration of the Exoatmospheric Kill Vehicle (EKV), which began emplacements in fiscal year 2009.

Source: Missile Defense Agency.



Program Essentials

Prime contractor: Boeing
Program office: Redstone Arsenal, AL
Funding FY12 to FY16:
  R&D: $4,716.6 million
  Procurement: $0.0 million
  Total funding: $4,758.8 million
  Procurement quantity: 0

Program Performance (fiscal year 2012 dollars in millions)

	As of	Latest 08/2011	Percent change
Research and development cost	NA	$38,919.8	NA
Procurement cost	NA	$0.0	NA
Total program cost	NA	$39,161.8	NA
Program unit cost	NA	NA	NA
Total quantities	NA	NA	NA
Acquisition cycle time (months)	NA	NA	NA

Costs are from program inception through fiscal year 2016.

MDA has used a highly concurrent development, production, and fielding strategy for CE-II interceptors, which carried significant risks, some of which were realized after its latest flight test failure. Twelve CE-II EKVs have been manufactured and delivered, but both attempts to verify its capability in flight have failed—the first because of a quality issue and the second because of a failure in the guidance system. The guidance system failure has resulted in design changes, and the risk of further changes on the program will remain until flight testing is complete. The program plans to verify the guidance system fixes through a nonintercept flight test in fiscal year 2012 and has halted the final integration of the remaining CE-II EKVs until it does so. The cost of the CE-II test failures, including costs of failure review, testing, redesigns, and retrofits, could exceed $1.2 billion.

Attainment of Product Knowledge

As of January 2012

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

BMDS: GMD Program

Technology Maturity

All nine technologies in the GMD operational configuration are mature, but two technologies in the enhanced CE-II interceptor—an upgraded infrared seeker and onboard discrimination—are only nearing maturity. Although the program has manufactured and delivered over 12 CE-II EKVs, its capability has yet to be demonstrated because it failed in its two intercept flight test attempts.

Design and Production Maturity

The GMD program has released all of its expected design drawings to manufacturing and has manufactured and delivered 12 interceptors, but the program remains at risk for design changes until it completes its flight test program, currently scheduled for 2021. For example, the December 2010 CE-II EKV intercept test failure resulted in design changes to resolve problems with the guidance system. These design changes are currently undergoing testing. Additionally, the interceptor design could still change because two of its technologies are not fully mature and have not had their capability verified through flight testing. We did not assess the maturity of production processes for the GMD interceptors. According to the program, the low number of planned quantities does not provide sufficient data to demonstrate its manufacturing processes are in statistical control.

Other Program Issues

MDA has used a highly concurrent development, production, and fielding strategy for CE-II interceptors, which carried significant risks, some of which were realized after its latest flight test failure. That failure has disrupted production, increased costs, and delayed fielding. GMD conducted an intercept flight test to assess the capability of the CE-II EKV in January 2010; however, it did not intercept the target because of a quality-control issue in the EKV. GMD reconducted this test in December 2010 and, although the booster and EKV launched successfully, the EKV failed to achieve an intercept because of a failure in the guidance system. After the test failure, the Director, MDA, halted the planned delivery of CE-II EKVs. In addition, the program deferred other planned fiscal year 2011 work in order to fund the activities necessary to conduct the failure investigation, as well as the resulting redesign efforts. The program plans to verify the fixes it is developing through a nonintercept flight test in fiscal year 2012. The flight test failures have cost MDA hundreds of millions of dollars thus far, and the eventual cost to demonstrate the CE-II through flight testing is likely to be around $1 billion. In addition to the costs of the actual flight tests, the Defense Contract Management Agency reported that mitigating the hardware problems that contributed to the failures will be very expensive and time consuming.

Consequently, the program will have to undertake another major retrofit program for the CE-II EKVs that have already been manufactured. According to GMD program officials, the total cost for this retrofit effort has not been determined, but they expect the effort to cost about $18 million per fielded interceptor resulting in an additional cost of $180 million.

Program Office Comments

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

BMDS: Terminal High Altitude Area Defense (THAAD)

MDA's THAAD is being developed as a rapidly-deployable, ground-based missile defense system with the capability to defend against short- and medium-range ballistic missiles during their late midcourse and terminal phases. A THAAD battery includes interceptors, launchers, an X-band radar, a fire control and communications system, and other support equipment. MDA is scheduled to deliver the first two of nine planned THAAD batteries to the Army in fiscal year 2012 for initial operational use.

Source: Missile Defense Agency.

Technology/system development | **Initial capability**

- Program start (1/92)
- Transition to MDA (10/01)
- Contract award for batteries 1 & 2 (12/06)
- Contract award for battery 3 interceptors (3/11)
- First operational flight test (10/11)
- GAO review (1/12)
- Conditional materiel release to Army (2012)

Program Essentials

Prime contractor: Lockheed Martin
Program office: Huntsville, AL
Funding FY12 to FY16:
R&D: $1,451.9 million
Procurement: $4,049.2 million
Total funding: $5,839.0 million
Procurement quantity: NA

Program Performance (fiscal year 2012 dollars in millions)

	As of	Latest 08/2011	Percent change
Research and development cost	NA	$16,146.2	NA
Procurement cost	NA	$5,458.9	NA
Total program cost	NA	$21,942.9	NA
Program unit cost	NA	NA	NA
Total quantities	NA	NA	NA
Acquisition cycle time (months)	NA	NA	NA

Costs are from program inception through fiscal year 2016.

THAAD's major components are mature and its design is currently stable. The number of design drawings has increased by about 30 percent since production began in 2006, due in part to design changes on a critical safety system. Production issues, driven mostly by design changes, have delayed interceptor deliveries by 18 months and have cost the program nearly $40 million. In fiscal year 2011, the program mitigated some of these issues and was able to meet or exceed its production goals for the first several months of fiscal year 2012. The program still must demonstrate that it can steadily produce at this rate over time. THAAD also conducted its first operational flight test in October 2011—a significant event for the program.

Attainment of Product Knowledge

As of January 2012

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

BMDS: THAAD Program

Technology and Design Maturity

The THAAD program's major components—the fire control and communications system, interceptor, launcher, and radar—are mature, and the prime contractor has released all of the expected design drawings. However, the number of design drawings has increased by approximately 30 percent since production started in December 2006, due in part to design changes for a safety system called an optical block, which prevents inadvertent launches, and associated changes to the flight sequencing assembly, which houses the optical block. According to program officials, the program considered further design changes, which were estimated to cost approximately $150 million, to the optical block in fiscal year 2011 to make it more producible. However, program management decided not to make those changes because of improved manufacturing performance and program funding constraints. In addition, the current design was demonstrated in an October 2011 flight test and in other testing needed to support an upcoming materiel release decision. Therefore, the program determined that the benefits of continuing the redesign no longer justified the cost.

Production Maturity

MDA awarded a contract for its first two initial operational batteries in December 2006 before developmental testing of all of the system's critical components had been completed. Production issues have delayed interceptor deliveries for the first two batteries by 18 months and have cost the program nearly $40 million. We have previously reported that design changes and producibility issues prevented the interceptor subcontractor from demonstrating the program's planned production rate. The program devised a new testing process to increase production and, according to program officials, the production-rate goal was met in early fiscal year 2012. However, they noted that production rates might be artificially high because the program was able to amass other subcomponents while it was working through interceptor production issues. Consequently, the program still must demonstrate that it can steadily produce at this rate.

Other Program Issues

THAAD conducted its first operational flight test in October 2011—a significant event for the program. Army and DOD test and evaluation organizations were both involved to ensure that the test's execution and results were representative of the operational environment for the fielded system. During the test, the THAAD system engaged and simultaneously intercepted two short-range ballistic missile targets. Army and MDA test organizations will use this test to conduct an operational assessment of the THAAD system. DOD's independent test organization will also use the results to evaluate THAAD's operational effectiveness.

The THAAD program is expecting the system to be approved for conditional materiel release to the Army in the second quarter of fiscal year 2012. For materiel release to occur, the Army must certify that the batteries are safe, suitable, and logistically supported. Conditional materiel release is an interim step in the Army's process and was originally expected to occur in September 2010, but was delayed first by interceptor safety issues, and more recently by the decision to consider data from THAAD's October 2011 operational flight test. A date for the Army's full materiel release decision has not been established. According to program officials, MDA cannot set a target date until it receives the Army's definitive list of conditions that need to be met and funding to address them.

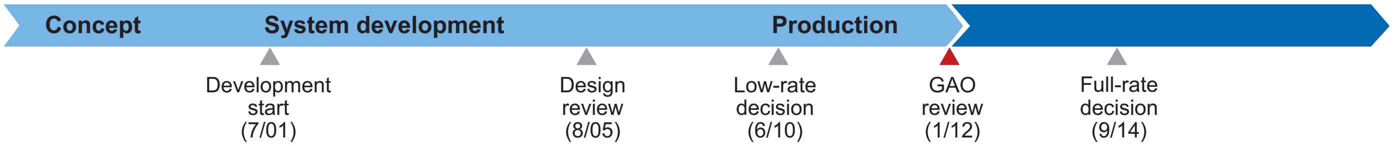
Program Office Comments

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

C-130 Avionics Modernization Program (AMP)

The Air Force's C-130 AMP will standardize and upgrade the cockpit and avionics for the three combat configurations of the C-130 fleet. The upgrades are intended to ensure that the C-130 can satisfy the navigation and safety requirements it needs to operate globally. The program will also replace many systems that are no longer supportable due to diminishing manufacturing resources. These efforts are expected to increase the reliability, maintainability, and sustainability of the upgraded aircraft.

Source: U.S. Air Force.



Program Essentials

Prime contractor: Boeing
Program office: Wright-Patterson AFB, OH
Funding needed to complete:
  R&D: $42.2 million
  Procurement: $3,890.4 million
  Total funding: $3,932.6 million
  Procurement quantity: 208

Program Performance (fiscal year 2012 dollars in millions)

	As of 07/2001	Latest 12/2010	Percent change
Research and development cost	$775.4	$1,948.3	151.3
Procurement cost	$3,356.8	$4,256.0	26.8
Total program cost	$4,132.3	$6,204.3	50.1
Program unit cost	$7.962	$28.074	252.6
Total quantities	519	221	-57.4
Acquisition cycle time (months)	NA	NA	NA

The C-130 AMP entered production in 2010; however, it experienced a greater number of design changes than anticipated in fiscal year 2011 as new software was added to address deficiencies found in testing. The program's critical technologies are mature and a 2008 production readiness review concluded that production processes were mature and ready to start initial production. The program plans to award a second low-rate production contract and that contractor will compete with Boeing for the full-rate production contract. Maturity of production processes for the second source will be assessed prior to the contract award. The full-rate production decision has slipped from February 2013 to September 2014 to provide the second contractor sufficient hands-on experience with AMP kit installation to compete. Officials reported that during the delay, Boeing will also address software issues.

Attainment of Product Knowledge

As of January 2012

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

C-130 AMP Program

Technology and Design Maturity

The C-130 AMP's critical technologies are mature and its design appears stable; however, the program experienced a somewhat greater number of design changes than anticipated in fiscal year 2011. According to the program office, all of the expected engineering drawings for the C-130 AMP combat delivery configuration were releasable to manufacturing, but a software build was added to the program to address problems found in developmental testing. Specifically, testers found that the core avionics were not well adapted to the C-130's tactical missions and crew workload needed to be reduced during airdrop and low-level operations, as well as those flown in certain formations. The software to address these deficiencies will not be completed and evaluated in time to be included in initial operational test and evaluation. Program officials said the software will be tested beginning in August 2012, a month after operational testing is scheduled to be completed. Officials expect software testing to be completed in advance of the program's full-rate production decision.

Production Maturity

The C-130 AMP received approval to enter low-rate production in June 2010—2 years after a production readiness review concluded that the processes used by Boeing and an Air Force air logistics center were mature and ready to start initial production. Three aircraft have received the AMP modification and the program is meeting or exceeding the quality metrics on which it provided data. However, the program did not assess the manufacturing readiness of key suppliers prior to production. Program officials plan to do so in 2012 and will develop manufacturing maturity plans as needed in order to demonstrate the suppliers' readiness to begin full-rate production.

According to program officials, Boeing will provide all 26 low-rate initial production AMP kits and up to nine installations for the first five production lots. An Air Force logistics center will install kits for the first and second lots of production. Installation of kits for lots 3 through 5 will be completed by Boeing and an Air Force logistics center, as well as a second industry source, to facilitate competition with Boeing for the full-rate production contract. Program officials expect to award a contract to the second contractor in January 2012. Program officials reported that the maturity of production processes of contractors being considered for lots 3 through 5 will be assessed prior to the contract award.

Other Program Issues

The program's full-rate production decision has been delayed 19 months, from February 2013 to September 2014. Program officials stated the delay was necessary to provide a second contractor sufficient hands-on experience with AMP kit installation prior to the contract award for full-rate production. They reported that the program added a fifth low-rate production lot to provide time for the second contractor to accumulate this experience and avoid a production break. The second contractor will compete with Boeing for the full-rate production contract to build and install the AMP kits. An Air Force air logistics center will continue to install AMP kits during full-rate production as well. Program officials stated the delay in full-rate production will also give the program adequate time to complete and test the additional software build.

Program Office Comments

In commenting on a draft of this assessment, the Air Force stated that a source-familiarization phase is being implemented during low-rate initial production to provide a second contractor with sufficient hands-on AMP kit installation experience. The second contractor will then compete with Boeing in a limited competition for full-rate production. Officials also noted that in December 2010, the full-rate production decision was moved from February 2013 to September 2014 to provide the second contractor sufficient hands-on experience prior to proposal submittal to ensure a robust competition. The Air Force also provided technical comments, which were incorporated as appropriate.

GAO Response

After we completed our assessment, DOD proposed cancelling the C-130 AMP program in the President's Budget for Fiscal Year 2013.

CH-53K - Heavy Lift Replacement

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: © 2011 Sikorsky Aircraft Corporation.

Program Essentials

Prime contractor: Sikorsky Aircraft Corporation
Program office: Patuxent River, MD
Funding needed to complete:
  R&D: $3,252.9 million
  Procurement: $16,381.7 million
  Total funding: $19,634.6 million
  Procurement quantity: 196

Program Performance (fiscal year 2012 dollars in millions)

	As of 12/2005	Latest 08/2011	Percent change
Research and development cost	$4,378.9	$6,058.1	38.3
Procurement cost	$12,178.3	$16,381.7	34.5
Total program cost	$16,557.1	$22,439.9	35.5
Program unit cost	$106.136	$112.199	5.7
Total quantities	156	200	28.2
Acquisition cycle time (months)	119	157	31.9

The CH-53K program completed its critical design review in July 2010 with a stable design, but without fully maturing its critical technologies or demonstrating that its design can perform as expected. As a result, the risk of design changes remains. Flight testing is expected to begin in 2014 and the program expects its critical technologies to be demonstrated in a realistic environment by its August 2015 production decision. According to program officials, the program has begun building test aircraft, which should help demonstrate its manufacturing processes before production begins. The CH-53K development contract increased by $724 million to better reflect cost estimates the program has reported since 2009, and several key events were delayed. According to program officials, these changes do not affect the dates of the production decision or initial operational capability.

Attainment of Product Knowledge

As of January 2012

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 Maturity

The CH-53K program began system development in 2005 with immature critical technologies. After 4 years in development, the program's two current critical technologies—the main rotor blade and the main gearbox—were determined to be nearing maturity in February 2010 after being demonstrated in a relevant environment. The program expects these technologies to be demonstrated in a realistic environment by its planned August 2015 production decision. Flight testing of the program's four engineering development models is expected to begin in 2014.

Design Maturity

The CH-53K design appears stable, but it has not been demonstrated using a prototype to show that it will perform as expected. This will not occur until at least 2013. According to the program office, all of the CH-53K's expected design drawings are releasable. However, the continuing maturation of the program's critical technologies could result in design changes as testing progresses.

Production Maturity

According to program officials, the CH-53K program has begun building developmental aircraft and a ground test vehicle. These test articles are being assembled in the same facility where production of the CH-53K is planned to take place. Production of the ground test vehicle began in July 2011 and the first of four engineering development models entered the production line in January 2012. Additionally, program officials stated the completion of the ground test vehicle has been delayed because of problems with the quality of the main gear box castings. However, they believe these problems have been corrected.

Other Program Issues

The CH-53K development contract has increased in cost and several key events have been delayed. Program officials reported that in July 2011, the contract's estimated cost was increased by $724 million to $3.4 billion. According to Defense Contract Management Agency officials, the estimated contract costs increased because of several factors including the need for additional flight test hours and spare parts, increased material costs, and design complexity. The contract was also changed from cost-plus award fee to cost-plus incentive fee for the remaining period of performance. The incentive fees are tied to specific cost and schedule goals. In August 2011, the contract's schedule was rebaselined and several key production and testing events were delayed. For example, the delivery dates for the program's engineering development models were moved back and its first flight was delayed from 2013 to 2014. According to program officials, these contract changes will not affect the dates for the CH-53K's production decision or delivery of an initial operational capability.

In 2008, the Marine Corps directed the CH-53K program to increase the number of planned aircraft from 156 to 200 to support an increase in strength from 174,000 to 202,000 Marines. In February 2011, the Secretary of Defense testified that the number of Marine Corps troops may decrease by up to 20,000 beginning in fiscal year 2015. According to Marine Corps officials, a force structure review has been conducted to assess the required quantity of aircraft and that review determined that the requirement for 200 aircraft is still valid despite the proposed manpower reduction.

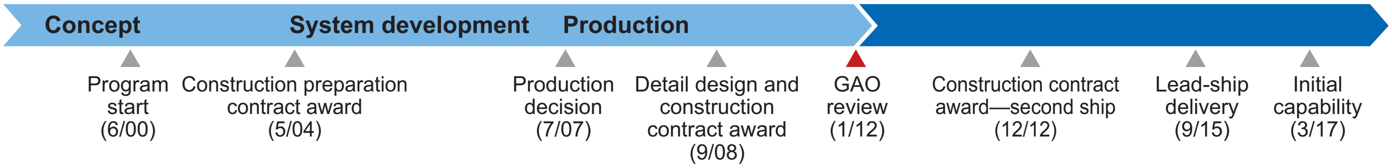
Program Office Comments

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

CVN 78 Class

The Navy's CVN 78 class of nuclear-powered aircraft carriers are being designed to improve operational efficiency, enable higher sortie rates, and reduce manpower through the use of advanced propulsion, aircraft launch and recovery, and survivability technologies. The Navy awarded a contract for detail design and construction of the lead ship, CVN 78, in September 2008 and expects it to be delivered by September 2015. The Navy plans to award the construction contract for CVN 79 in December 2012 and CVN 80 by the end of 2017.

Source: U.S. Navy.



Program Essentials

Prime contractor: Huntington Ingalls Industries–Newport News
Program office: Washington, DC
Funding needed to complete:
  R&D: $827.7 million
  Procurement: $16,540.9 million
  Total funding: $17,368.6 million
  Procurement quantity: 2

Program Performance (fiscal year 2012 dollars in millions)

	As of 04/2004	Latest 08/2011	Percent change
Research and development cost	$4,803.3	$4,646.8	-3.3
Procurement cost	$30,770.8	$29,346.8	-4.6
Total program cost	$35,574.1	$33,993.6	-4.4
Program unit cost	$11,858.040	$11,331.185	-4.4
Total quantities	3	3	0.0
Acquisition cycle time (months)	137	155	13.1

When the CVN 78 construction contract was awarded in September 2008, the program had several immature technologies and an incomplete three-dimensional product model. The ship's model is now complete, but 7 of the program's 13 critical technologies still have not been tested in a realistic environment. The electromagnetic aircraft launch system (EMALS) and dual-band radar continue to pose cost and schedule risks and neither system will be fully integrated and tested until after they are on-board. CVN 78's procurement cost has grown by about 10 percent over the past 3 years. Cost growth has been driven by construction cost increases, which the program largely attributes to the immaturity of the ship's technologies and design when the construction contract was awarded. The cost growth may require the program to request additional funding or reduce the ship's capabilities.

Attainment of Product Knowledge

As of January 2012

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 Class Program

Technology Maturity

Seven of the CVN 78 program's 13 current critical technologies have not been tested in a realistic, at-sea environment, including two technologies—EMALS and the dual-band radar—which continue to pose risks. According to program officials, EMALS has successfully launched F/A-18E, T-45C, C-2A, and E-2D aircraft during testing; however, the system has not demonstrated the required level of reliability because of the slow correction of problems discovered earlier in testing. In addition, according to officials, EMALS motor generators have only been tested in a group of 4, rather than the group of 12 that will make up the system. A test of the complete system will not take place until it is aboard the ship. The dual-band radar also will not complete testing until after it is aboard the ship, which presents a risk if the system does not work as intended. The radar is required for ship installation starting in March 2013, but the program does not expect to complete testing the multifunction radar component until early 2013 or begin testing the volume-search radar component until May 2013. Some radar subsystems will not be tested until aboard the CVN 78. In addition, less dual-band radar testing has been done than anticipated because the Navy eliminated the volume-search component of the radar from the DDG 1000 Destroyer program, which the CVN 78 had planned to leverage. CVN 78 will now be the first ship to operate with this radar, but as of August 2011, the Navy had not yet planned for carrier-specific testing. Program officials also noted that the Evolved Sea Sparrow Missile will be demonstrated in a relevant environment by March 2012, at which point all critical technologies will have been demonstrated in a relevant environment.

Design Maturity

The CVN 78 program completed its three-dimensional product model in November 2009—over a year after the award of the construction contract. At the time of the September 2008 contract award, only 76 percent of the ship's three-dimensional product model was complete and the shipbuilder had already begun construction of at least 25 percent of the ship's structural units under its previous construction preparation contract. Program officials noted that while there had been concerns about the ability of the ship's jet blast deflectors to work effectively with the carrier variant of the Joint Strike Fighter, these concerns have been addressed and will not require major design changes. Additional design changes are still possible as EMALS and other systems continue testing.

Production Maturity

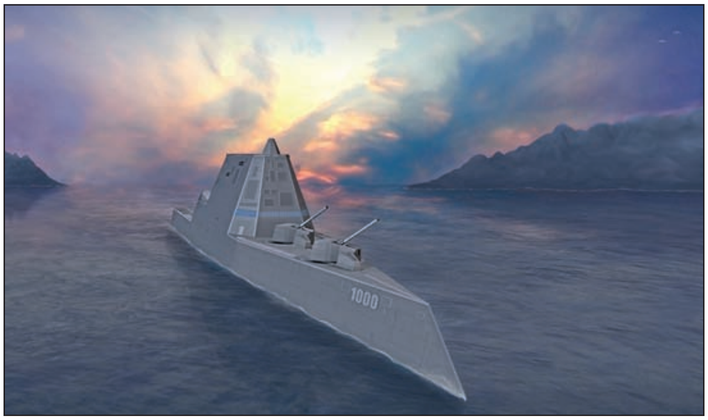
Procurement costs for CVN 78 have grown by about 10 percent over the past 3 years. A key driver is an increase in construction costs. According to the program, 83 percent of the ship's structural units are complete, constituting almost 27 percent of the expected labor hours. However, the program estimates that the labor hours to complete the ship will be 4 million more than the 40 million hours originally budgeted. The program believes the cost and labor-hour increases are largely due to the immaturity of the ship's technologies and design when the construction contract was awarded. Program officials also cited problems such as late material deliveries, an unexpected need for more structural support to achieve a thinner deck structure, and material deficiencies on developmental components such as valves. According to the program, the growth in construction costs may require requests for additional funding or a reduction of the ship's capabilities.

Program Office Comments

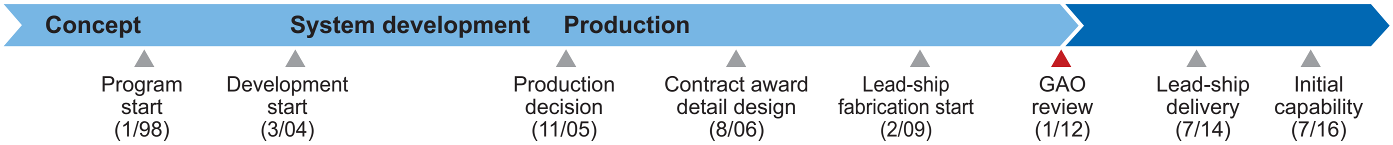
In commenting on a draft of this assessment, the program noted that dual-band radar testing, while impacted by DDG 1000 decisions on volume-search radar, is fully funded and will complete land-based tests and begin shipboard testing prior to delivery.

DDG 1000 Destroyer

The Navy's DDG 1000 destroyer is a multimission surface ship designed to provide advanced land-attack capability in support of forces ashore and littoral operations. The ship will feature a low radar profile, an advanced gun system, and a total ship computing environment intended to improve the speed of command and reduce manning. Fabrication has begun on the first two ships and is planned to begin on the third ship in fiscal year 2012.



Source: U.S. Navy.



Program Essentials

Prime contractor: BAE Systems, Bath Iron Works, Huntington Ingalls Industries, Raytheon
Program office: Washington, DC
Funding needed to complete:
  R&D: $995.6 million
  Procurement: $1,418.1 million
  Total funding: $2,413.6 million
  Procurement quantity: 0

Program Performance (fiscal year 2012 dollars in millions)

	As of 01/1998	Latest 08/2011	Percent change
Research and development cost	$2,277.9	$10,378.4	355.6
Procurement cost	$32,522.1	$10,607.2	-67.4
Total program cost	$34,800.0	$20,985.6	-39.7
Program unit cost	$1,087.500	$6,995.214	543.2
Total quantities	32	3	-90.6
Acquisition cycle time (months)	128	222	73.4

The DDG 1000 design is stable and all three ships are in or will soon be in fabrication. However, the program is still conducting development work on several of its critical technologies and most of them will not be fully mature and demonstrated in a realistic environment until after their installation on the ship. One of the technologies—the advanced gun system's long-range land-attack projectile—continued to experience delays due to issues with its rocket motor. The Navy plans to finalize and test the rocket motor design by March 2012. The first two ships are approximately 63 percent and 22 percent complete, respectively. According to program officials, the shipbuilder had to rework some areas on the first ship, which resulted in an 8-week schedule delay, but only minor cost increases. The Navy has noted improvements in fabrication on the second ship.

Attainment of Product Knowledge

As of January 2012

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 is still conducting development work on several of its critical technologies. Three of DDG 1000's 12 critical technologies are currently mature and the integrated deckhouse will be delivered to the first ship for installation in fiscal year 2012. However, the remaining eight technologies will not be demonstrated in a realistic environment until after ship installation. The Navy has completed a successful full-power test of the integrated power system—one of these eight technologies—and plans a follow-on test in fiscal year 2012. Another critical technology—the total ship computing environment—consisted initially of six software releases. According to program officials, software release 5 has been completed and was used in land-based testing in fiscal year 2011. The program has made changes to release 6, and has prioritized the software needed to support shipyard delivery over the functionality needed for activating the mission systems. This functionality was moved out of the releases and will be developed as part of a spiral. Other key technologies, including the multifunction radar and the advanced gun system, have been delivered to the first ship. However, the gun system's long-range land-attack projectile has encountered delays, primarily due to problems with its rocket motor. The Navy plans to finalize and test the rocket motor design by March 2012. The Navy has performed several guided flight tests using older rocket motor designs, which demonstrated that the projectile can meet its accuracy and range requirements.

Design and Production Maturity

The DDG 1000 design is stable, although the potential for design changes remains until its critical technologies are fully mature. There have been few design changes resulting from lead-ship production, which program officials attribute to a high level of design maturity prior to fabrication. As of January 2012, the Navy estimated that the first ship, which began fabrication in February 2009, was 63 percent complete. The second ship, which began fabrication in March 2010, is 22 percent complete.

Shipbuilders have experienced several challenges in constructing the first and second ships, including issues with the manufacture and installation of certain composite materials. According to program officials, the shipbuilder had to rework some areas, which resulted in an 8-week schedule delay, but only minor cost increases. Program officials noted that the shipbuilder has developed and refined manufacturing and installation processes to reduce the likelihood of rework on the subsequent ships.

Other Program Issues

Following a Nunn-McCurdy unit-cost breach of the critical threshold in 2010, DOD restructured the DDG 1000 program and removed the volume-search radar from the ship's design. The program will modify the multifunction radar to meet its volume-search requirements.

The Navy recently awarded contracts for fabrication of the third ship, its gun system, and software development and integration. In these negotiations, program officials said the Navy leveraged its knowledge about actual costs from the fabrication of the first two ships and from other programs to reduce costs. According to program officials, the Navy is in negotiations for contracts related to the mission systems and other key segments of the third ship.

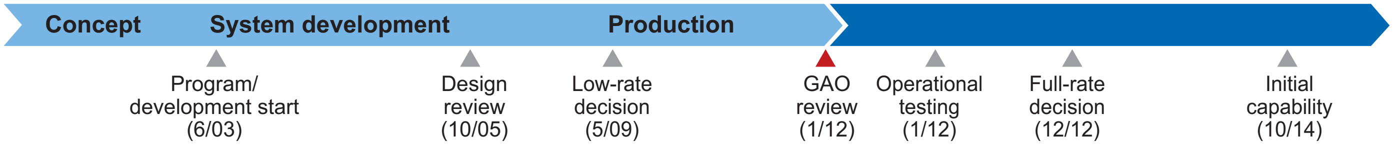
Program Office Comments

In commenting on a draft of this assessment, Navy officials confirmed that the program was recertified and restructured in June 2010 following a Nunn-McCurdy unit-cost breach and the curtailing of the program to three ships. Since then, the Navy has awarded ship construction contracts for all three ships, including advanced guns and all required software. All critical technologies have been tested in at least a relevant environment. Officials noted that more than 90 percent of the software has been completed through design, code, unit test, and integration and its schedule is aligned to ship activations. Navy officials also said that program reviews by the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics and DOD's Office of Performance Assessment and Root Cause Analyses concluded that the Navy is managing and retiring program risk. The Navy also provided technical comments, which were incorporated as appropriate.

E-2D Advanced Hawkeye (E-2D AHE)

The Navy's E-2D AHE is an all-weather, twin-engine, carrier-based aircraft designed to extend early warning surveillance capabilities. It is the next in a series of upgrades the Navy has made to the E-2C Hawkeye platform since its first flight in 1971. The key objectives of the E-2D AHE are to improve target detection and situational awareness, especially in the littorals; support theater air and missile defense operations; and provide improved operational availability for the radar system.

Source: U.S. Navy.



Program Essentials

Prime contractor: Northrop Grumman
Program office: Patuxent River, MD
Funding needed to complete:
R&D: $367.8 million
Procurement: $10,874.7 million
Total funding: $11,257.5 million
Procurement quantity: 60

Program Performance (fiscal year 2012 dollars in millions)

	As of 06/2003	Latest 08/2011	Percent change
Research and development cost	$3,841.0	$4,537.9	18.1
Procurement cost	$10,911.1	$13,167.1	20.7
Total program cost	$14,752.0	$17,747.3	20.3
Program unit cost	$196.694	$236.630	20.3
Total quantities	75	75	0.0
Acquisition cycle time (months)	95	136	43.2

The E-2D AHE's critical technologies are mature, its design is stable, and its production processes have been demonstrated. According to E-2D program office and Defense Contract Management Agency (DCMA) officials, the contractor is also performing well on a variety of production metrics. The program continues to make progress completing development test points and addressing issues identified in the 2010 operational assessment, but it delayed initial operational test and evaluation from November 2011 to January 2012. The program office continues to improve the radar's reliability rate, which is currently 71 hours, but DOD test organizations expressed some concern about whether the radar will be able to meet some reliability and performance measures during initial operational test and evaluation.

Attainment of Product Knowledge

As of January 2012

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

E-2D AHE Program

Technology and Design Maturity

According to the Navy, all five of the E-2D AHE's critical technologies are mature and its design is stable. Program officials told us that an increase in design drawings over the last year was primarily due to changes made to address issues identified during development testing. None of the test discoveries resulted in major changes to the aircraft design, and DCMA officials confirmed that these design changes were relatively minor.

Production Maturity

The E-2D AHE's production processes have been demonstrated. According to the E-2D program office and DCMA officials, the contractor is performing well on a variety of production metrics and the program has not identified any issues that would result in cost or schedule growth on the production contract. The contractor reports monthly to DCMA and the program office on a series of production metrics, such as scrap and rework rates. The program did not identify any critical manufacturing processes associated with the E-2D AHE, nor does the program require the contractor's major assembly site to use statistical process controls to ensure its critical processes are producing high-quality and reliable products because components are assembled using manual processes that do not lend themselves to such measures.

Other Program Issues

The program continues to make progress completing development test points and addressing issues identified in the 2010 operational assessment, but it delayed initial operational test and evaluation from November 2011 to January 2012. Some development test points related to the Cooperative Engagement Capability (CEC) remain to be completed. The CEC is a system that integrates information from multiple sources to track potential targets and is being developed by a separate Navy program office. The E-2D program could not test this capability as scheduled because of late deliveries from the CEC program. The E-2D program has now received the CEC and plans to test it before the start of initial operational testing.

The program office continues to improve the radar's reliability. The E-2D program reported the current radar reliability rate is 71 hours. The radar must achieve a rate of 81 hours prior to the decision to enter full-rate production, which is scheduled for December 2012. DOD test organizations expressed some concern about whether the radar will be able to meet some reliability and performance measures during initial operational test and evaluation. However, initial results from a test exercise conducted in November partially addressed the performance concerns, according to an official at a DOD test organization.

As part of DOD's better-buying-power initiatives, the E-2D AHE program conducted a should cost analysis prior to the negotiation of its third production contract. According to program officials, it used the results of this analysis to achieve a 4.5 percent cost savings on this contract.

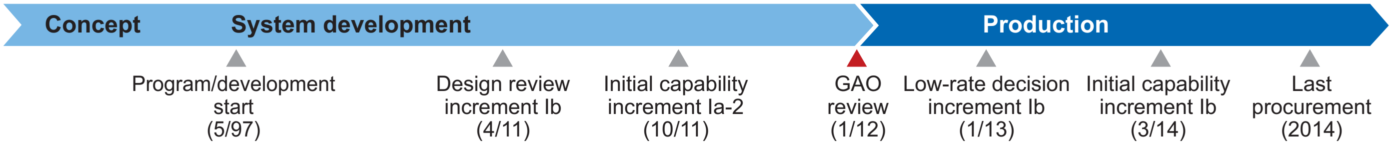
Program Office Comments

In commenting on a draft of this assessment, Navy officials noted that the program has completed all the testing required on the E-2D itself before entering initial operational test and evaluation, although some testing of the CEC system remains. The Navy also provided technical comments, which were incorporated as appropriate.

Excalibur Precision Guided Extended Range Artillery Projectile

The Army's Excalibur is a family of global positioning system–based, fire-and-forget, 155 mm 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 a three-phased 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, will begin production in 2013. We assessed increment Ib.

Source: U.S. Army.



Program Essentials

Prime contractor: Raytheon
Program office: Picatinny Arsenal, NJ
Funding needed to complete:
  R&D: $50.2 million
  Procurement: $234.9 million
  Total funding: $285.1 million
  Procurement quantity: 3,455

Program Performance (fiscal year 2012 dollars in millions)

	As of 02/2003	Latest 08/2011	Percent change
Research and development cost	$765.5	$1,068.3	39.6
Procurement cost	$4,010.8	$712.1	-82.2
Total program cost	$4,776.2	$1,780.5	-62.7
Program unit cost	$.062	$.238	282.4
Total quantities	76,677	7,474	-90.3
Acquisition cycle time (months)	136	173	27.2

Total quantities include 3,455 increment Ib projectiles.

The Excalibur program will have to resolve several increment Ib design issues before its planned January 2013 production decision. In August 2010, the Army began system development for increment Ib with its one critical technology nearing maturity. The increment Ib design review was held in April 2011 and while all the expected design drawings were releasable, parts of the design were found to be incomplete and noncompliant. Additional subsystem design reviews will be required to certify the design is complete. The program is conducting a series of tests in advance of its production decision to ensure performance and safety requirements can be met. Reliability testing will not be complete until after production has begun. The program experienced a Nunn-McCurdy unit-cost breach of the critical threshold in 2010 due to a reduction in quantities, but was certified to continue in 2011.

Attainment of Product Knowledge

As of January 2012

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 Maturity

After an 18-month prototype design and demonstration phase, the Army began system development for increment Ib in August 2010 with its one critical technology—the guidance system—nearing maturity. According to the program office, the guidance system is now mature.

Design Maturity

The Excalibur program will have to resolve several increment Ib design issues before its design can be considered stable. The majority of the increment Ib design is complete and all of the program's current design drawings were released by its April 2011 design review. However, the design review panel indicated that three of the eight projectile subassemblies—the base assembly, fuze safe and arm device, and tactical telemetry module—had incomplete designs. Those subassemblies will require additional subsystem-level design reviews and testing before their designs can be considered complete. Further, although the majority of the design appears to comply with current program requirements, the program does not currently meet requirements related to insensitive munitions, the range of the gun, and the fuze setting timeline. Ensuring compliance with these requirements could require design changes, and the program is uncertain of the total number of drawings that will ultimately be required for the projectile.

The program is beginning integrated developmental and operational testing to prepare for the January 2013 production decision for increment Ib. Design verification testing was conducted in May and July 2011 to characterize the performance and structural integrity of the design for the Ib base as well as to gather aerodynamic data on the latest design. The Army also plans to perform sequential environment tests to evaluate the performance, reliability, and lethality of the projectiles under a broad range of conditions. All performance and safety requirements are expected to be met before the production decision. However, reliability testing will not be complete until after production has begun.

Production Maturity

The lack of a complete and stable design has prevented the Excalibur program from demonstrating the level of manufacturing maturity for increment Ib expected for a program that is preparing to enter production. The increment Ib will use similar manufacturing processes as the increment Ia, which the program assesses as mature. However, according to the increment Ib June 2011 capability production document, final manufacturing processes have not yet been demonstrated at two key suppliers because of incomplete or changing designs.

Other Program Issues

In May 2010, the Army reduced program quantities from 30,000 to 6,264 based on a review of precision munition needs. The resulting unit-cost increase led to a Nunn-McCurdy unit-cost breach of the critical threshold. A January 2011 program review concluded that the program is essential to national security and no alternatives are available to provide the same capability at a lower cost. As a result, in January 2011, the restructured Excalibur program was certified to continue. The restructured program plans to save $24 million by increasing the rate of increment Ib production and using fixed-price contracts with economic price adjustments for steel.

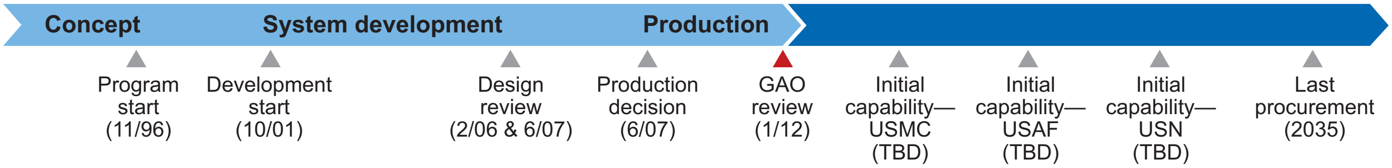
Program Office Comments

In commenting on a draft of this assessment, the Army stated that the program does not currently meet requirements related to insensitive munitions due to the lack of a qualified explosive, and the fuse setting due to a new requirement to clear cryptographic keys prior to loading the new key. Ensuring compliance with the insensitive munitions requirement would require an insensitive explosive qualification program and subsequent warhead qualification, which would delay the program and increase costs. The fuze setting timeline is currently within less than one second of the requirement. Changing the requirement to allow the system to overwrite previously entered keys would allow this requirement to be met. The Army further stated that manufacturing processes will be demonstrated and reviewed prior to the production decision. The Army also provided technical comments, which were incorporated as appropriate.

F-35 Lightning II (Joint Strike Fighter)

DOD's JSF 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-18 E/F. The Air Force variant will primarily replace the air-to-ground attack capabilities of the F-16 and A-10, and will complement the F-22. The short take-off and vertical landing variant will replace the Marine Corps F/A-18 and AV-8B aircraft.

Source: 2010 Lockheed Martin.



Program Essentials

Prime contractor: Lockheed Martin, Pratt and Whitney
Program office: Arlington, VA
Funding needed to complete:
R&D: $10,117.8 million
Procurement: $245,676.5 million
Total funding: $255,970.4 million
Procurement quantity: 2,353

Program Performance (fiscal year 2012 dollars in millions)

	As of 10/2001	Latest 12/2010	Percent change
Research and development cost	$38,976.7	$58,387.6	49.8
Procurement cost	$172,921.4	$267,595.6	54.7
Total program cost	$213,708.2	$326,535.2	52.8
Program unit cost	$74.567	$132.900	78.2
Total quantities	2,866	2,457	-14.3
Acquisition cycle time (months)	116	TBD	NA

Latest column does not fully reflect the restructured JSF program. Costs are expected to grow and the schedule will be extended.

The JSF program has awarded contracts for production aircraft, but it still lacks key knowledge about its technologies and manufacturing processes. Four critical technologies are not mature and present significant development risks as the program integrates and tests them. The program is making progress in flight testing, but much of its developmental and operational testing remains and the risk of future design changes is significant. Manufacturing inefficiencies, parts shortages, and quality issues persist, but there has been some improvement. The program has been restructured to address development challenges, which triggered a Nunn-McCurdy unit-cost breach of the critical threshold. Aircraft quantities have been reduced in the near term to reduce risk and offset increased development funding needs. DOD has not yet approved a new baseline for the program.

Attainment of Product Knowledge

As of January 2012

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

JSF Program

Technology Maturity

The JSF program began system development with none of its eight critical technologies mature; and, according to program officials, four of these technologies—mission systems integration, which includes the helmet-mounted display; the prognostics and health management system; integrated core processor; and integrated support systems—are still not fully mature. Deficiencies in the helmet-mounted display prompted the program to develop a second helmet. The program is also trying to fix the first helmet, which does not currently meet system requirements. Significant development risks remain as the program integrates and tests these technologies.

Design Maturity

The JSF program did not have a stable design at its critical design reviews. The program has now released 96 percent of its total expected design drawings; however, it continues to experience design changes. With most of developmental and operational flight testing still ahead, the risk of future design changes and their potential effects on the program could be significant.

Production Maturity

The JSF program's manufacturing processes have not been fully demonstrated as only 24 percent of the critical processes are in statistical control. The prime contractor has made manufacturing process improvements and some key production metrics are improving. However, manufacturing inefficiencies persist, primarily driven by parts shortages, parts quality issues, and technical changes arising from discoveries during test events, indicating that the aircraft's design and production processes may still lack the maturity needed to efficiently produce aircraft at planned rates. The prime contractor planned to deliver 16 production aircraft in 2011, but only 9 were delivered. Reintroduction of the carrier variant into the production line has resulted in parts shortages and out-of-station work, which can be highly inefficient. The prime contractor is also managing hundreds of suppliers within a global network, which adds to the complexity of producing aircraft efficiently and on-time. In addition, extensive testing remains to be completed and the program could be required to alter production processes, change its supplier base, and retrofit produced and fielded aircraft if problems are discovered.

Other Program Issues

DOD has restructured the JSF program by adding more time and money to address development challenges and reducing near-term quantities to reduce risk and offset the additional development costs. The projected cost of the restructured program triggered a Nunn-McCurdy unit-cost breach of the critical threshold in 2010. At the time of our assessment, the program had not yet completed a DOD review at which time the program's updated cost and schedule estimates may be approved. According to program officials, the services are also assessing the effect of the program changes and have not yet determined new initial operational capability dates for any of the variants.

All but one of the initial test assets have been delivered to their respective test locations, and the program made significantly more progress in flight testing compared to the previous year. The short take-off and vertical landing variant successfully completed initial ship trials. However, the program continues to experience challenges in developing and integrating the large and complex software requirements needed to achieve JSF capabilities, which could slow testing.

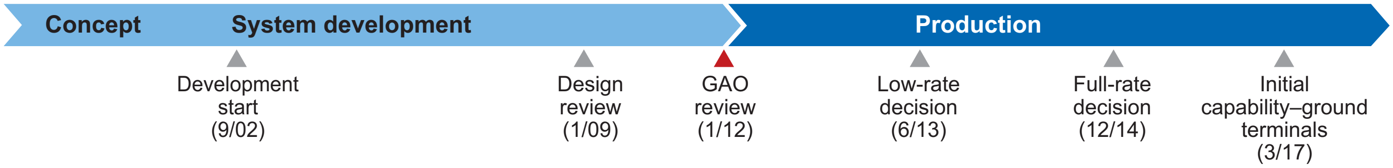
Program Office Comments

In commenting on a draft of this assessment, DOD noted that the JSF program has 10 years of development and aircraft in production. In reference to the helmet, officials explained that due to the need to demonstrate at the milestone B recertification that all technologies had been demonstrated in at least a relevant environment, the program is adding a second helmet as a risk-reduction effort while continuing to improve the first helmet. The program has a plan to mitigate development risks for the original helmet through developmental testing. DOD also provided technical comments, which were incorporated as appropriate.

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 that will replace many program-unique terminals. It is being designed to work with current and future communications capabilities and technologies. FAB-T is expected to provide voice and data military satellite communications for nuclear and conventional forces as well as airborne and ground command posts, including B-2, B-52, RC-135, E-6, and E-4 aircraft.

Source: U.S. Air Force.



Program Essentials

Prime contractor: Boeing
Program office: Hanscom AFB, MA
Funding needed to complete:
  R&D: $571.4 million
  Procurement: $2,338.6 million
  Total funding: $2,910.0 million
  Procurement quantity: 216

Program Performance (fiscal year 2012 dollars in millions)

	As of 12/2006	Latest 08/2011	Percent change
Research and development cost	$1,537.1	$2,338.7	52.2
Procurement cost	$1,651.4	$2,349.6	42.3
Total program cost	$3,188.5	$4,688.3	47.0
Program unit cost	$14.762	$19.058	29.1
Total quantities	216	246	13.9
Acquisition cycle time (months)	129	174	34.9

The latest cost data do not reflect the current cost of the program. A new acquisition program baseline has not yet been approved.

The FAB-T program has gained key knowledge about its critical technologies and design, but it faces several cost, schedule, and development challenges. In 2010, the program extended development and has since delayed production by more than 3 years. The program's software development schedule is still unrealistic. There has been an increase in productivity, but development may be completed 4 to 8 months behind the new schedule. In addition, a high-priority presidential and national voice conferencing requirement has not yet been put under contract. The program will likely breach critical Nunn-McCurdy unit-cost thresholds unless it can achieve significant savings from its revised acquisition strategy, which includes competition for FAB-T development and production. There will be continued uncertainty about the program's cost until a new acquisition program baseline is approved.

Attainment of Product Knowledge

As of January 2012

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 Maturity

According to the FAB-T program, all six of its critical technologies are mature. These technologies have been demonstrated in recent testing—both in-flight and with a satellite simulator.

Design Maturity

The FAB-T's design is currently stable; however, design changes are likely as the program addresses new requirements. The program reported that 98 percent of its total expected design drawings were releasable, but the number of design changes was somewhat greater than anticipated in fiscal year 2011. In addition, the U.S. Strategic Command has requested that a new, high-priority requirement for presidential and national voice conferencing be added to the program. Program officials stated that requirements development and design activities related to this capability began in October 2011, but the engineering changes to the terminal will not be put under contract until spring 2012.

Software development and testing remain major challenges for the program. An April 2011 independent review team found that the software development schedule could not be met without extraordinary productivity growth. In response, program officials told us that they have put in place metrics to manage the effort, revised the test schedule, and increased the government's presence at the contractor's facility. According to program officials, there has been an increase in productivity; however, the program is still behind schedule and development could be completed 4 to 8 months late.

Other Program Issues

The FAB-T program was restructured in 2010 and its acquisition strategy is being revised, but a new acquisition program baseline that reflects these changes and their projected costs has not yet been approved. As part of the restructuring, the program extended its system development phase and delayed its production decision by more than 3 years to June 2013. In October 2010, an independent review team noted that the program was likely in breach of critical Nunn-McCurdy unit-cost thresholds; however, a breach has not yet been reported by the program. The FAB-T program plans to change its acquisition strategy to competitively award contracts for development and production. Program officials said they expect to achieve significant savings in production by using this approach. They also stated that a recent independent cost estimate showed substantial cost growth in the program, but it did not reflect the competitive strategy, which is still under review. A new independent cost estimate, which includes the competitive strategy and new voice conferencing requirement, is expected to be conducted by October 2012.

Due to uncertainty about FAB-T, the Air Force stopped work on contracts related to its integration with the B-2 and B-52—the two bomber platforms for which it is designed. According to officials, both programs are considering alternatives to transmit data through AEHF satellites, which is an important capability for strategic platforms. However, FAB-T might not be able to provide its full range of planned communications capabilities if the bomber programs pursue alternatives since some of its capabilities are based on the interaction of bomber aircraft with intelligence, surveillance, and reconnaissance aircraft and ground terminals.

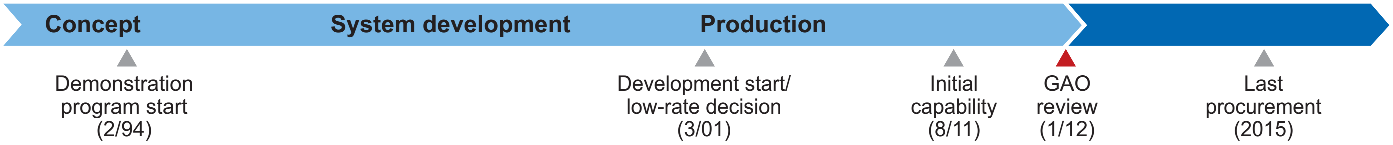
Program Office Comments

In commenting on a draft of this assessment, the Air Force stated that the FAB-T program is executing the Under Secretary of Defense for Acquisition, Technology and Logistics' January 2012 acquisition decision memorandum, which directed it to establish a competitively awarded fixed-price development and production approach by placing priority on the air and ground command post terminals to provide a presidential and national voice conferencing capability. In addition, the memorandum also directed the program to complete an independent cost estimate and revised acquisition program baseline prior to the award of an alternate source. In parallel with executing the memorandum, the program office is considering converting the current cost-plus award fee contract into a firm fixed-price contract in order to reduce the government's cost risk. The Air Force also provided technical comments, which were incorporated as appropriate.

Global Hawk (RQ-4A/B)

The Air Force’s Global Hawk is a high-altitude, long-endurance unmanned aircraft that provides intelligence, surveillance, and reconnaissance capabilities. The Global Hawk will replace the U-2. After a successful technology demonstration, the system entered development and limited production in March 2001. The early RQ-4A, similar to the original demonstrators, was retired in 2011, leaving a fleet of the larger and more capable RQ-4Bs. We assessed the RQ-4B, which is being produced in 3 configurations—block 20, 30, and 40.

Source: Northrop Grumman.



Program Essentials

Prime contractor: Northrop Grumman
Program office: Wright-Patterson AFB, OH
Funding needed to complete:
- R&D: $1,657.1 million
- Procurement: $3,098.9 million
- Total funding: $4,789.4 million
- Procurement quantity: 13

Program Performance (fiscal year 2012 dollars in millions)

	As of 03/2001	Latest 10/2011	Percent change
Research and development cost	$1,041.6	$4,769.3	357.9
Procurement cost	$4,318.8	$7,877.4	82.4
Total program cost	$5,392.0	$12,811.6	137.6
Program unit cost	$85.588	$232.938	172.2
Total quantities	63	55	-12.7
Acquisition cycle time (months)	55	125	127.3

The Global Hawk program has utilized a concurrent testing and production strategy, which put it at increased risk of cost growth. The program procured all of its block 20 and more than half of its block 30 aircraft before completing operational testing in 2010 and plans to procure all of its block 40 aircraft before it begins operational testing in 2013. In May 2011, the Director, Operational Test and Evaluation, found that the block 30 system was not operationally effective or suitable and provided several recommendations to improve the aircraft’s capability and reliability. The program has addressed most of the test findings. The program also reported a critical Nunn-McCurdy cost breach to Congress in April 2011 and has been restructured. The planned dates for remaining key events have been delayed by an additional 6 months or more and the number of aircraft has been decreased to 55.

Attainment of Product Knowledge

As of January 2012

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

Global Hawk Program

Technology, Design, and Production Maturity

The critical technologies for the RQ-4B are mature, its basic airframe design is stable, and its manufacturing processes are mature and in statistical control. The RQ-4B aircraft is being produced in three configurations. Block 20 aircraft are equipped with an enhanced imagery intelligence payload, block 30 aircraft have both imagery and signals intelligence payloads, and block 40 aircraft will have an advanced radar surveillance capability. All six block 20 aircraft have been produced and production continues on block 30 and block 40 aircraft. However, the program must still successfully test one of its key capabilities for block 40 aircraft—the multiple platform radar—to ensure it performs as expected. Developmental testing of the multiple platform radar is now underway, but the program remains at risk for late design changes if problems are discovered in testing.

Other Program Issues

The Global Hawk program has utilized a concurrent testing and production strategy, which put it at increased risk of cost growth. The program procured all of its block 20 and more than half of its block 30 aircraft by the time it completed operational testing in December 2010. On the basis of the results of this testing, the Director, Operational Test and Evaluation, reported in May 2011 that the block 30 system was neither operationally effective nor operationally suitable for conducting near-continuous, persistent intelligence, surveillance, and reconnaissance based on the Air Force Concept of Employment, and made several recommendations to improve the system's capabilities, situational awareness, and reliability. According to program officials, they have addressed most of the problems identified in operational testing and have plans in place to correct the remainder. Initial operational capability was declared for block 30 aircraft in August 2011. The program also plans to procure all of its block 40 aircraft before its projected start of operational testing in October 2013, putting it at increased risk of costly retrofits if problems are discovered.

In 2011, the Global Hawk program reported a Nunn-McCurdy unit-cost breach of the critical cost growth threshold and was restructured. The program office attributed the cost growth to changes in the quantities of block 30 and block 40 aircraft, increases in support costs, and the revised architecture of its ground station and communication systems. DOD also pointed to the presence of known, but unfunded, requirements and an unrealistic schedule as root causes for much of the cost growth. The restructured program includes four separate subprograms—block 10/20, block 30, block 40, and ground station and communications. The block 30 and 40 subprograms will hold new production decision reviews in early 2012. The ground station and communications subprogram is scheduled to begin system development in summer 2013. The program also has five performance requirements that were part of its existing baseline that will not be available in the required timeline. As a result of actions taken in DOD's fiscal year 2012 budget and the Nunn-McCurdy process, the planned quantities for the program have been decreased from 77 aircraft to 55 aircraft and aircraft procurement is scheduled to be completed in 2015.

Program Office Comments

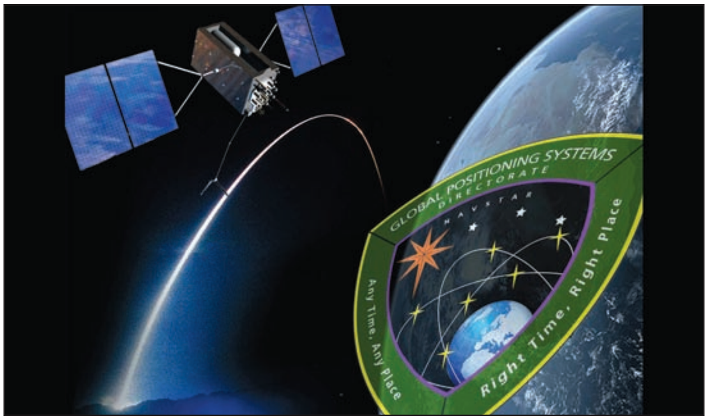
In commenting on a draft of this assessment, the Air Force stated that in 2011 the program deployed its block 30 systems and they are operational in theater. The program is also addressing challenges to increase reliability, availability, maintainability, and effective time-on-station metrics for the system. In addition to commenting on this assessment, the Air Force provided technical comments, which we incorporated where appropriate.

GAO Response

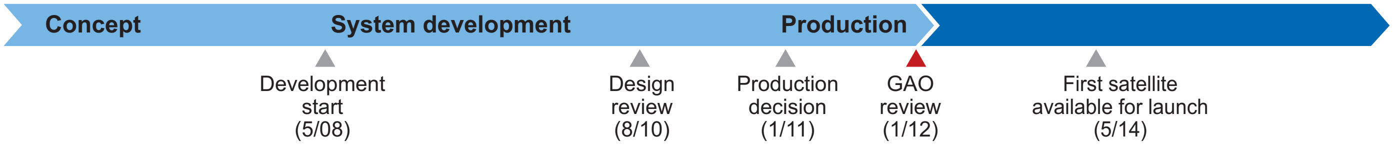
In January 2012, DOD announced its plan to terminate the Global Hawk block 30 system in fiscal year 2013, due to the high cost associated with the program.

Global Positioning System (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 such as 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: $924.6 million
- Procurement: $1,435.0 million
- Total funding: $2,359.6 million
- Procurement quantity: 6

Program Performance (fiscal year 2012 dollars in millions)

	As of 05/2008	Latest 08/2011	Percent change
Research and development cost	$2,524.2	$2,694.8	6.8
Procurement cost	$1,417.2	$1,515.8	7.0
Total program cost	$3,941.4	$4,210.6	6.8
Program unit cost	$492.672	$526.323	6.8
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.

The GPS III entered production in January 2011 with mature technologies and some of the knowledge needed to ensure the system would work as intended and could be manufactured efficiently. A complete satellite was not tested prior to the production decision, but the program is developing prototypes of the spacecraft and payload to prove out production processes and identify and solve issues prior to integrating and testing the first space vehicle. The GPS III is experiencing cost growth and the contractor is behind schedule, but the program does not expect these delays to affect the launch of the first satellite. There are risks to the program launching some satellites as planned. The GPS III ground control system is not scheduled for delivery until 15 months after the first scheduled launch and it is unclear whether an interim capability will be delivered in time.

Attainment of Product Knowledge

As of January 2012

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 and Design Maturity

The GPS III program's critical technologies are mature and its design is stable. The critical technologies changed as the program developed its design, but all eight current technologies have been demonstrated in a relevant environment. The GPS program office reported that the number of design changes since its design review has been much less than anticipated. In addition, according to the program office, some of the system's flight software has completed qualification testing and other software deliverables are on schedule.

Production Maturity

The GPS III program captured some of the knowledge needed to ensure the system would work as intended and could be manufactured efficiently before its January 2011 production decision. In 2011, the program office reported a level of manufacturing process maturity that indicated that its processes were in control when a production decision was made. A complete GPS III satellite was not tested prior to the production decision, but the program is developing prototypes of the spacecraft and payload to prove out production processes and identify and solve issues prior to integrating and testing the first space vehicle.

Other Program Issues

The GPS III program has adopted several practices to reduce program risk. It has maintained stable requirements and is being managed using a "back to basics" approach, which features rigorous systems engineering, use of military specifications and standards, and an incremental approach to providing capability. However, the GPS III program is currently experiencing cost growth and the contractor is behind schedule. In November 2011, the contractor's estimated cost at completion for the development and production of the first two satellites was over $1.4 billion or 18 percent greater than originally estimated; the program office estimated the cost to be about $1.6 billion. The Air Force has cited multiple reasons for the projected contract cost increases including reductions in the program's production rate; greater than expected efforts to produce engineering products compliant with more stringent parts, materials, and radiation testing requirements; test equipment delays; and inefficiencies in the development of both the navigation and communication payload and satellite bus. The contractor is also behind in completing some tasks, but the program does not expect these delays to affect the launch of the first satellite.

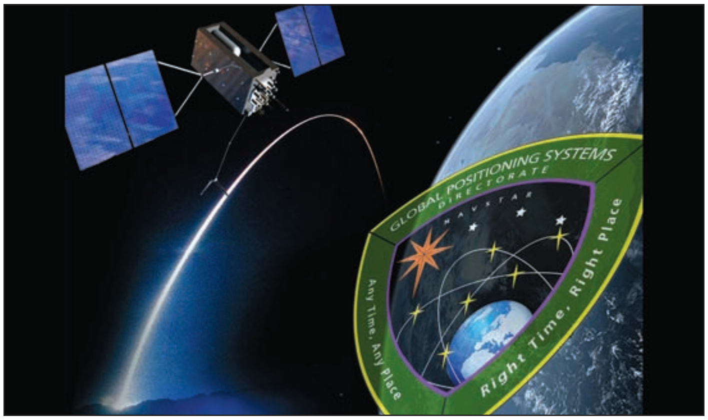
The GPS directorate has taken steps to mitigate GPS III's dependence on the development schedule for the next-generation GPS ground control system, the OCX, which is being managed as a separate major defense acquisition program, but some GPS III launches could be affected if OCX is delayed. The contractor plans to deliver GPS OCX Block I in August 2015—15 months after the first planned GPS III satellite launch. The GPS directorate is funding the development of a launch and checkout system that will provide an earlier command and control capability for the first GPS III satellite, but it unclear when this system will be delivered. According to GPS directorate officials, this system will not enable the new capabilities offered by GPS III satellites, including a jam-resistant military signal and three new civil signals. GPS program officials stated previously that they would prefer not to launch a second satellite until the capabilities of the first one are fully tested. Although the Air Force has slowed its planned pace of launches for GPS III so that there should not be a rapid succession of launches within 2 years of the first GPS III launch, further delays in the OCX program could still affect the dates of some GPS III launches.

Program Office Comments

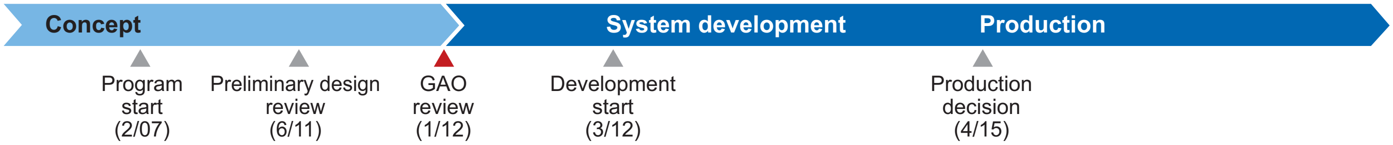
In commenting on a draft of this assessment, the GPS III program provided technical comments, which were incorporated as appropriate.

GPS III OCX Ground Control Segment

The Air Force's next-generation GPS control segment, referred to as OCX, will provide command, control, and mission support for the GPS Block II and III satellites. OCX is expected to ensure reliable and secure delivery of position and timing information to GPS military and civilian users. The Air Force plans to develop OCX in four blocks, with each block delivering upgrades as they become available. We assessed the first block, which will support the operation of GPS Block II and Block III satellites.



Source: U.S. Air Force.



Program Essentials

Prime contractor: Raytheon
Program office: El Segundo, CA
Funding FY12 to FY16:
  R&D: $1,583.9 million
  Procurement: $35.6 million
  Total funding: $1,619.5 million
  Procurement quantity: NA

Program Performance (fiscal year 2012 dollars in millions)

	As of	Latest 09/2011	Percent change
Research and development cost	NA	$2,538.5	NA
Procurement cost	NA	$35.6	NA
Total program cost	NA	$2,574.1	NA
Program unit cost	NA	NA	NA
Total quantities	NA	NA	NA
Acquisition cycle time (months)	NA	NA	NA

Table includes costs from program inception through fiscal year 2016.

GPS OCX plans to enter system development in March 2012 with some of the recommended knowledge about its requirements and technologies. The program held a preliminary design review in June 2011 and its critical technologies are nearing maturity. The Air Force awarded a cost-reimbursement contract for Blocks I and II in February 2010 before it received approval to formally enter system development. The first two software packages have been completed, but the complexity of the software development effort has proven challenging. The GPS OCX will not be fielded in time to support the first GPS III satellite, which is scheduled for launch in May 2014. As a result, the GPS directorate is funding an effort to provide an earlier command and control capability, but this system will not enable the new capabilities offered by that satellite.

Attainment of Product Knowledge

Projected as of January 2012

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

According to program officials, the GPS OCX plans to enter system development in March 2012 with its 14 critical technologies nearing maturity. However, these technologies will not be fully tested and demonstrated in a realistic environment until the program makes its production decision. The program held a preliminary design review in June 2011, which was completed in August 2011, and has addressed most of the issues that were identified during the review. The remaining issues, which the program deems low risk, relate to better defining certain requirements, including those for reliability. The program office developed mitigation plans to address these issues and an independent review team approved the plans as well as the design and architecture of the OCX system.

Other Program Issues

The complexity of the GPS OCX software development effort has proven challenging and two current software efforts were started behind schedule. According to the program office, the GPS OCX contract requires the delivery of six Block I software iterations by February 2015 and two Block II software iterations by March 2016. According to program officials, the first and second Block I iterations were completed on schedule; however, the third iteration was started later than planned and is expected to be completed later than originally scheduled as well. Preliminary work has begun on the fourth iteration, which is also running behind schedule. The primary reasons for the delay in the delivery of the third iteration, and the late start of the fourth iteration, were the difficulty of developing new code, as well as the contractor's focus on getting through the preliminary design review process, which, according to program officials, required more work than the contractor originally anticipated.

According to program officials, because of the complexity of the GPS OCX software, the program has instituted a rigorous testing process to identify and address defects early in each iteration. The program expects that this process will reduce the number of defects discovered in higher-level integration and testing, which can be more costly to resolve. This testing approach has already identified a number of defects in the early iterations, and the number of defects that are being found during integration testing has been lower than expected.

The contractor plans to deliver GPS OCX Block I in August 2015—15 months after the first planned GPS III satellite launch. As a result, the GPS directorate is funding the development of a launch and checkout system that will provide an earlier launch and command and control capability for the first GPS III satellite. According to GPS directorate officials, this system will not enable the new capabilities offered by GPS III satellites, including a jam-resistant military signal and three new civil signals. The program released a request for proposal for the launch and checkout system in April 2011 and awarded the effort in December 2011. The launch and checkout system is expected to cost about $30 million through 2015. Any delay in the delivery of the launch and checkout system could potentially cause the Air Force to delay the launch of the first GPS III satellite.

Program Office Comments

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

Gray Eagle Unmanned Aircraft System

The Army's MQ-1C Gray Eagle will perform reconnaissance, surveillance, target acquisition, and attack missions either alone or with other platforms such as the Longbow Apache helicopter. In 2010, the Army changed the number of Gray Eagle systems from 13 company-sized units with 12 aircraft to 31 platoons with 4 aircraft. Each platoon will also include payloads, data terminals, and other ground support equipment. The program consists of block 1 systems and two less-capable Quick Reaction Capability systems. We assessed block 1.

Source: General Atomics Aeronautical Systems, Inc.

Program Essentials

Prime contractor: General Atomics Aeronautical Systems, Inc.
Program office: Redstone Arsenal, AL
Funding needed to complete:
  R&D: $226.1 million
  Procurement: $2,089.0 million
  Total funding: $3,006.9 million
  Procurement quantity: 16

Program Performance (fiscal year 2012 dollars in millions)

	As of 04/2005	Latest 08/2011	Percent change
Research and development cost	$344.9	$946.2	174.4
Procurement cost	$670.4	$3,400.2	407.2
Total program cost	$1,015.2	$5,158.9	408.2
Program unit cost	$203.046	$166.416	-18.0
Total quantities	5	31	520.0
Acquisition cycle time (months)	50	TBD	NA

Total quantities include 31 platoon sets with 4 aircraft each. The program will also buy 21 aircraft to replace those lost through attrition and 7 training aircraft, for a total of 152.

The Gray Eagle program began production in February 2010 with three of its five critical technologies not yet mature and manufacturing processes that still exhibited production risks. The program has demonstrated two of those technologies in a realistic environment and expects to demonstrate the third one in fiscal year 2012. A March 2011 aircraft accident resulted in hardware and software changes. Some of the changes required retrofits to systems already produced. As a result of the accident, the Army delayed the program's initial operational test and evaluation and full-rate production decision. To avoid a production break, the Army plans to award a third low-rate production contract in May 2012. It now plans to procure more than half of the total aircraft before the system is fully tested.

Attainment of Product Knowledge

As of January 2012

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

Gray Eagle Program

Technology Maturity

The Gray Eagle entered production in February 2010 without all five of its critical technologies mature. An Army technology readiness assessment, which was approved by the Office of the Director, Defense Research and Engineering, in 2009, concluded that three of those technologies—automatic take-off and landing, manned-unmanned teaming, and the tactical common data link—had not been fully demonstrated in an operational environment. According to the program office, the automatic take-off and landing system is now mature, and manned-unmanned teaming was demonstrated in 2011 with an Apache helicopter controlling Gray Eagle. However, the tactical common data link is still not fully mature. The program office stated that the data link encryption capability was successfully tested in 2011, but its air data relay capability has been deferred until fiscal year 2012.

Design Maturity

The program office believes the Gray Eagle design is currently stable; however, the program has experienced a significant increase in design drawings due to issues identified during testing and other technical changes. The program has made modifications to the system's software and hardware following a March 2011 accident and system testing. The Army has installed the software changes on aircraft that were in production as well as fielded aircraft, and plans to make hardware changes that include redesigning the aircraft's rudders. The program office stated that it does not yet know the cost or schedule for completing these modifications.

Production Maturity

Gray Eagle began production in February 2010 with manufacturing processes that had been demonstrated on a pilot production line, but still exhibited production risks. An independent Army assessment of the program's production readiness in 2009 stated that manufacturing process maturity was satisfactory and manufacturing infrastructure met or exceeded requirements for low-rate initial production. It is unclear whether the Army expects planned hardware redesigns to affect the maturity of the Gray Eagle's production processes. If tooling or other manufacturing changes are necessary, its production processes could be affected.

Other Program Issues

The March 2011 accident involving an MQ-1C in testing has delayed several key program events. According to the program office, the accident investigation made it difficult to accumulate flight hours and conduct the soldier training needed to support initial operational test and evaluation in October 2011. The Army now plans to start operational testing in August 2012. As a result of the delay in operational testing, the program's full-rate production decision was postponed from August 2012 to March 2013. The Army has already awarded two low-rate production contracts in 2010 and 2011 for 55 aircraft. To avoid a break in production, the Army is planning to seek approval to award a third low-rate contract for 29 aircraft in May 2012. Based on the current program schedule, the Army will procure more than half of the total planned aircraft before the system's operational effectiveness and suitability is fully tested during initial operational test and evaluation.

Program Office Comments

In commenting on a draft of this assessment, the program office stated the Gray Eagle baseline design is mature. The program also indicated that changes to the system's software and hardware are planned improvements as new payloads and capabilities are integrated. Additionally, the program office noted that the automatic take-off and landing system and tactical common data link have been demonstrated because deployed units have been operating with these technologies. The program anticipates that the data link's air data relay capability will be operationally tested in August 2012 and manned-unmanned teaming with an Apache Block III helicopter will be operationally tested in March 2012. The program also provided technical comments, which were incorporated as appropriate.

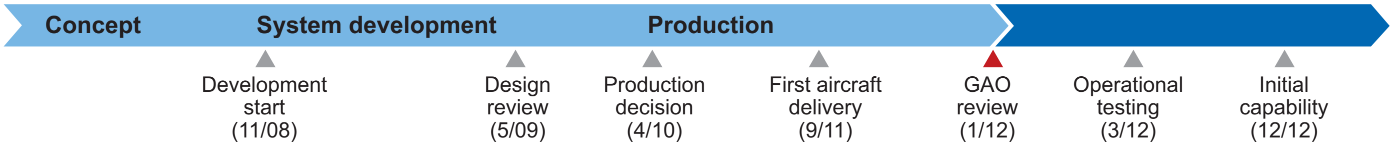
GAO Response

The program office considers the Gray Eagle baseline design mature, but the tactical common data link's full capabilities have not yet been tested. Additionally, as the program office noted, the Army will be modifying the aircraft tail rudder and elevator. Until the data link is fully mature and all design changes have been developed and incorporated, the program's cost and schedule remain at risk.

HC/MC-130 Recapitalization Program

The Air Force's HC/MC-130 Recapitalization program will replace aging Air Force HC-130P/N and Air Force Special Operations Command MC-130E/P/W/H aircraft with a multimission tactical aircraft that is based on the KC-130J platform. The primary mission of HC/MC-130J aircraft will be to provide aerial refueling. It will also position, supply, resupply, and recover specialized tactical ground units. The program includes a base configuration and three increments that provide additional capabilities.

Source: Lockheed Martin.



Program Essentials

Prime contractor: Lockheed Martin
Program office: Wright-Patterson AFB, OH
Funding needed to complete:
  R&D: $82.6 million
  Procurement: $9,532.4 million
  Total funding: $9,812.7 million
  Procurement quantity: 91

Program Performance (fiscal year 2012 dollars in millions)

	As of 03/2010	Latest 12/2010	Percent change
Research and development cost	$153.2	$152.8	-0.3
Procurement cost	$7,699.3	$12,621.9	63.9
Total program cost	$8,364.2	$13,090.8	56.5
Program unit cost	$113.029	$107.302	-5.1
Total quantities	74	122	64.9
Acquisition cycle time (months)	NA	NA	NA

The HC/MC-130J program entered production in April 2010 with mature critical technologies, a stable design, and manufacturing processes that were in control. The HC/MC-130J design is derived from the KC-130J aerial refueling tanker, and shares many of the same technologies; the system that allows it to receive fuel in-flight and the electro-optical/infrared turret mount are unique. According to program officials, the HC/MC-130J has completed developmental testing and is scheduled to enter operational testing in March 2012. Operational testing will be conducted with increment 1–configured aircraft, which make up 10 of the planned total 122 aircraft. The program plans limited testing for increment 2, which will primarily focus on the integration of Large Aircraft Infrared Counter Measures (LAIRCM). Twenty-five increment 2 aircraft are already under contract.

Attainment of Product Knowledge

As of January 2012

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

HC/MC-130 Recapitalization Program

Technology Maturity

The HC/MC-130 Recapitalization program entered system development in November 2008 with both of its critical technologies mature. Several of the HC/MC-130J's technologies are common with the KC-130J, including the rotor wing aerial refueling system. According to program officials, the two HC/MC-130J critical technologies—the electro-optical/infrared turret mount and the universal aerial refueling receptacle slipway installation (UARRSI)—are unique to the aircraft. The UARRSI allows the HC/MC-130J to receive fuel in-flight, extending the range of the aircraft.

Design Maturity

The HC/MC-130J design is stable and over 90 percent of its drawings were released by the time the program held its critical design review in May 2009. The HC/MC-130J is about 90 percent common with the C-130J, which has contributed to the aircraft's design maturity and stability.

Production Maturity

The HC/MC-130J program entered production in April 2010 with manufacturing processes that were in control. In addition, program officials told us that rework rates for repairs and defects is trending downward and have been within the expected range. A combination of a labor force unaccustomed to the aircraft and a ramp-up in production contributed to the rework rates—factors common across the C-130J platform.

Other Program Issues

According to program officials, the HC/MC-130J successfully completed developmental testing on base-configured aircraft in August 2011, slightly ahead of schedule. Operational testing—scheduled to begin in March 2012—will be conducted on increment 1–configured aircraft, which make up 10 of the planned total 122 aircraft in the program. Program officials stated that the Office of the Director, Operational Test and Evaluation, certified increment 1 aircraft as being production-representative, which would make it appropriate for use in operational testing. Program officials noted that several software- and hardware-related watch items identified during contractor testing must be resolved prior to the start of operational testing; however, they described these items as relatively minor and easily correctable.

According to program officials, there will be limited testing of increment 2–configured aircraft. This testing will be focused primarily on the integration of the LAIRCM system. Although the basic LAIRCM system is in production, recently concluded testing on LAIRCM's upgraded missile warning system revealed deficiencies that may affect integration with HC/MC-130J. The HC/MC-130J program includes 40 increment 2 aircraft, 25 of which have already been placed under contract.

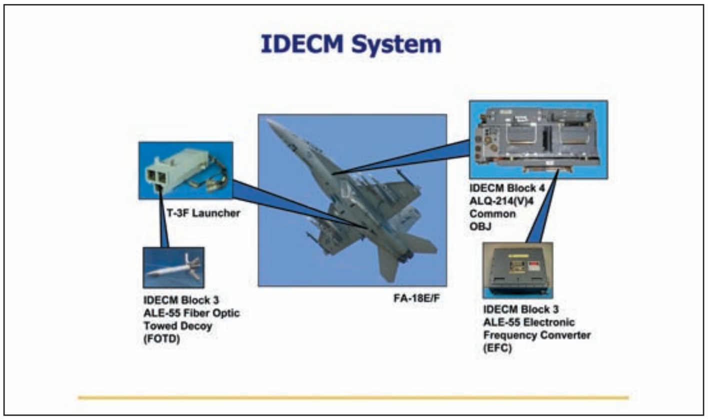
Due to the extended budget impasse for fiscal year 2011, the program office stated that it did not have sufficient authority under the continuing resolution to award a contract for nine aircraft as planned. In order to avoid a production break, the Air Force redirected approximately $500 million from other programs for the procurement of these aircraft. According to program offices, had an award not been made before the contractor's proposal expired in May 2011 the program would have been delayed by more than a year.

Program Office Comments

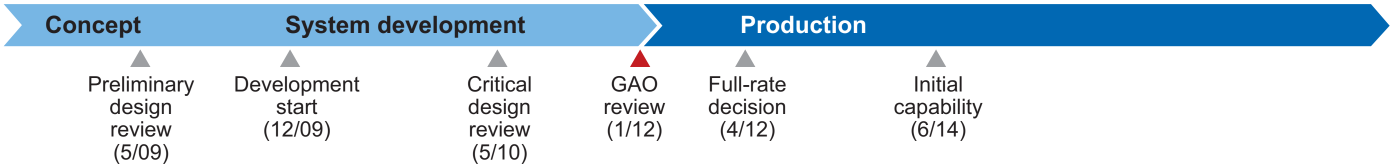
In commenting on a draft of this assessment, the Air Force provided technical comments, which were incorporated as appropriate.

Integrated Defensive Electronic Countermeasures (IDECM) Block 4

The Navy's IDECM is a radio-frequency, self-protection electronic countermeasure to improve the survivability of F/A-18 aircraft against guided threats during air-to-ground/surface and air-to-air missions. IDECM consists of onboard components that receive and process radar signals and onboard and offboard jammers. IDECM is being developed incrementally; each block improves its jamming or decoy capabilities. The Navy has fielded three IDECM blocks; block 4 will extend onboard jamming capabilities for F/A-18C/D aircraft. We assessed block 4.



Source: U.S. Navy.



Program Essentials

Prime contractor: ITT Electronic Systems
Program office: Patuxent River, MD
Funding needed to complete:
  R&D: $121.4 million
  Procurement: $569.5 million
  Total funding: $690.9 million
  Procurement quantity: 190

Program Performance (fiscal year 2012 dollars in millions)

	As of 06/2008	Latest 10/2011	Percent change
Research and development cost	$220.2	$252.0	14.5
Procurement cost	$474.2	$569.5	20.1
Total program cost	$694.4	$821.5	18.3
Program unit cost	$4.340	$4.324	-0.4
Total quantities	160	190	18.8
Acquisition cycle time (months)	59	54	-8.5

IDECM block 4 expects to begin production in April 2012 with mature technologies and a stable design. Block 4 primarily replaces the previous IDECM onboard jammer with a lightweight repackaged version. There is some concurrency risk on the program, which could drive costly design changes or retrofits if the redesigned jammer does not perform as intended. The Navy has no plans for low-rate initial production and will proceed to full-rate production before it completes ground and flight testing. Program officials stated that this concurrency is necessary in order to maintain the production line from block 3 to block 4 and to meet the June 2014 initial operational capability date. In addition, program officials noted that block 4 production will be limited initially to 19 units and the production rate will only increase once testing is completed.

Attainment of Product Knowledge

As of January 2012

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

IDECM Block 4 Program

Technology Maturity

IDECM block 4 began system development in 2009 as an engineering change proposal to the existing block 3 onboard jammer. Block 4 will reconfigure the ALQ-214 (V)3 onboard jammer, currently only installed in the F/A-18E/F aircraft, to a common configuration—ALQ-214 (V)4—to be installed on F/A-18C/D and F/A-18E/F aircraft. In April 2009, a technology readiness assessment concluded that there were no critical technologies in the ALQ-214 (V)4 and that the system was based on mature technologies.

Design and Production Maturity

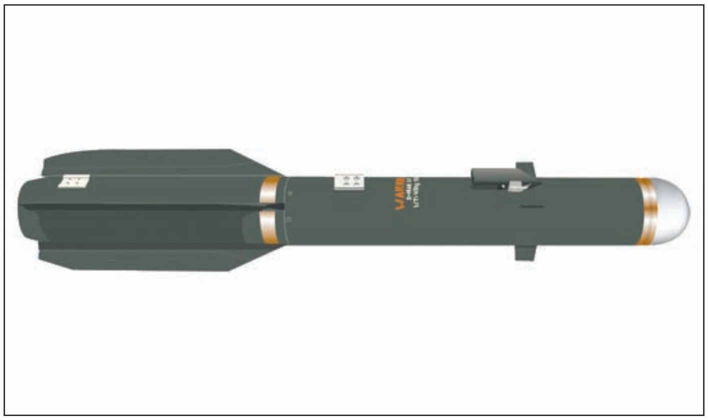
IDECM block 4's design is stable; however, there is still risk in the IDECM block 4 program because it expects to begin production in April 2012 before developmental testing is completed. The block 4 onboard jammer is a redesign of the jammer used in earlier blocks. This redesign was driven by the need to reduce weight in order to accommodate the IDECM onboard system on F/A-18C/D aircraft. The block 4 onboard jammer will perform the same function as found in IDECM blocks 2 and 3, but with a different form. The Navy expects to transition from block 3 production to block 4 production before the system completes ground and flight testing. The program will proceed directly into full-rate production. This concurrent production and testing strategy could drive costly design changes or retrofits, or both, to units in production if the redesigned jammer does not perform as intended. Officials stated that this concurrency is necessary in order to maintain the production line and to meet the June 2014 initial operational capability date for block 4. To mitigate the concurrency risk, Navy officials stated that block 4 production will be limited to 19 systems in 2012, with production rates increasing to as many as 40 systems per year following completion of testing.

Program Office Comments

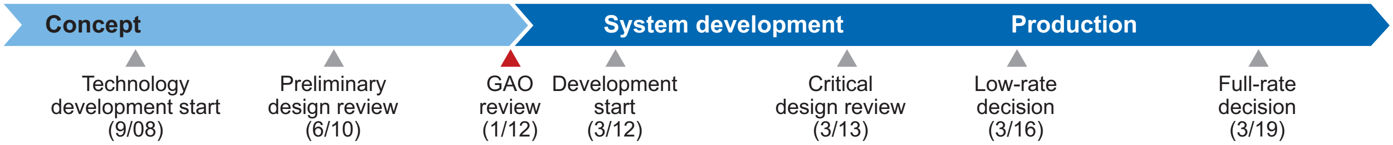
In commenting on a draft of this assessment, the Navy stated that the block 4 configuration will begin full-rate production in fiscal year 2012. The IDECM program office believes the cost risks associated with this production decision are low. While the production line transition to the new block 4 configuration will occur prior to the completion of flight testing in 2013, all testing will be completed prior to delivery of the production hardware and fleet introduction in 2014. To date, 13 systems have been delivered and utilized in developmental testing. In addition, the Navy noted that the firm fixed-price production contract requires the contractor to deliver assets that incorporate any design changes identified during testing. According to the Navy, the contractor would be required to retrofit changes into any assets already built at no additional cost to the government. The Navy also noted that the increase in the block 4 research and development cost estimate is associated with an additional requirement for an improved jamming capability against advanced threats. The increase in the procurement cost estimate is associated with a requirement for additional quantities.

Joint Air-to-Ground Missile (JAGM)

The Joint Air-to-Ground Missile is a joint Army/Navy program with Marine Corps participation. The missile will be air-launched from helicopters and fixed-wing aircraft and designed to target tanks; light armored vehicles; missile launchers; command, control, and communications vehicles; bunkers; and buildings. It is intended to provide line-of-sight and beyond line-of-sight capabilities and can be deployed in a fire-and-forget mode or a precision attack mode. JAGM will replace Hellfire, Maverick, and air-launched TOW missiles.



Source: Department of Defense.



Program Essentials

Prime contractor: TBD
Program office: Redstone Arsenal, AL
Funding needed to complete:
  R&D: $1,176.5 million
  Procurement: $5,113.0 million
  Total funding: $6,289.5 million
  Procurement quantity: 35,303

Program Performance (fiscal year 2012 dollars in millions)

	As of	Latest 11/2011	Percent change
Research and development cost	NA	$1,767.0	NA
Procurement cost	NA	$5,113.0	NA
Total program cost	NA	$6,880.0	NA
Program unit cost	NA	$.194	NA
Total quantities	NA	35,422	NA
Acquisition cycle time (months)	NA	TBD	NA

JAGM is expected to enter system development in 2012 with some of the recommended knowledge about its technology and requirements; however, the program's future is uncertain because of concerns about its affordability. According to the program office, the program held a preliminary design review in June 2010 and its five critical technologies are nearing maturity. However, an independent technology readiness assessment indicated that at least one technology has not reached this level of maturity. The program office incorporated a provision in the request for proposal for the system development contract that may mitigate the technology risk by requiring both competing contractors to submit two rocket motor designs. According to program officials, the program plans to award a contract in March 2012, despite ongoing uncertainty regarding the future of the program.

Attainment of Product Knowledge

Projected as of January 2012

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

JAGM Program

Technology Maturity

According to the program office, JAGM's five critical technologies are expected to be nearing maturity and demonstrated in a relevant environment before a decision is made to start system development. The critical technologies include a multimode seeker for increased countermeasure resistance, boost-sustain propulsion for increased standoff range, a multipurpose warhead for increased lethality, an inertial measurement unit for improved navigation and flight control, and guidance and control software. However, an independent technology readiness assessment indicated at least one of these technologies has not reached this level of maturity. We cannot identify the assessed maturity levels of individual technologies because the program is currently conducting a competition for its system development contract. According to program officials, the technology readiness assessment will be updated prior to development start based on contractors' proposals.

The program office incorporated a provision in the request for proposal that may mitigate some of the program's technology risk by requiring both competing contractors to submit two rocket motor designs. The government also planned to complete environmental and safety tests using eight rocket motors from each contractor during the technology development phase. The tests were intended to examine the rocket motors under the extremes of the expected operational environment to ensure they can perform safely and effectively. The tests were expected to be complete by December 2011.

Other Program Issues

The future of the JAGM program is uncertain because of concerns about its affordability. Army officials have stated that the service might not be able to afford JAGM, despite having a validated requirement for it. According to Army officials, the Hellfire missile, which JAGM is intended to replace, has been performing well in combat operations, and given budget constraints, the Army may prefer to extend its use indefinitely rather than pursue JAGM as a next generation solution. However, according to program officials, an analysis of alternatives completed in August 2011 indicated that JAGM is the most cost-effective solution to address warfighter needs. Program officials stated that the program plans to continue executing to its fiscal year 2012 budget plan. The Army will continue to field Hellfire missiles to meet the needs of the warfighter, while the Navy will rely on both Maverick and Hellfire missiles until the future of JAGM is determined.

According to program officials, the program plans to award its system development contract in March 2012, notwithstanding the uncertainty regarding JAGM's future. The program has received approval to conduct a limited competition between its two technology development contractors. It had intended to award the contract in December 2010; however, the release of the request for proposal was delayed until April 2011 because the program's acquisition strategy and requirements needed to be updated to reflect the cancellation of the Armed Reconnaissance Helicopter, the addition of the OH-58 Kiowa as a replacement platform, and new guidance on affordability.

Program Office Comments

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

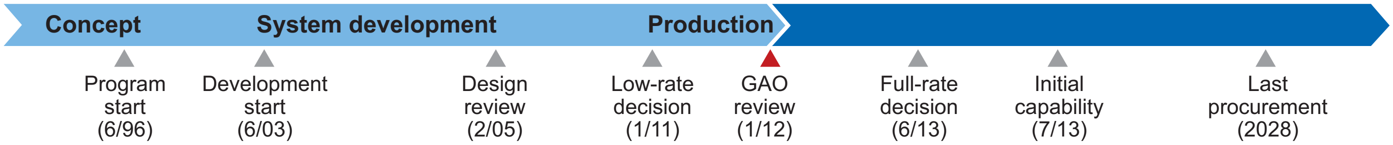
GAO Response

After our assessment was completed, the President's Budget for Fiscal Year 2013 extended JAGM's technology development phase by 27 months to address affordability issues and reduce risk prior to system development.

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

The Air Force's JASSM-ER program plans to field a next-generation cruise missile capable of destroying the enemy's war-sustaining capability from outside its air defenses. JASSM-ER missiles are 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: $65.5 million
Procurement: $3,389.3 million
Total funding: $3,454.9 million
Procurement quantity: 2,470

Program Performance (fiscal year 2012 dollars in millions)

	As of 04/2011	Latest 08/2011	Percent change
Research and development cost	$272.7	$272.7	0.0
Procurement cost	$3,457.7	$3,457.3	0.0
Total program cost	$3,730.5	$3,730.0	0.0
Program unit cost	$1.474	$1.474	0.0
Total quantities	2,531	2,531	0.0
Acquisition cycle time (months)	NA	NA	NA

JASSM-ER was approved to begin production in January 2011 with mature critical technologies, a stable design, and production processes that had been demonstrated, but were not in control. The JASSM-ER appears to have overcome past reliability issues and, according to program officials, the missile's design has been proven in flight testing. However, an engine oil leak was discovered in December 2011 that required the program office to return 13 engines to the manufacturer for corrective action, causing a 3- to 4-month delay in operational testing. In response to a warfighter request, the program is considering a significant increase in production rates starting in 2016. The program will need additional funding in the short term to increase production rates, but doing so could shorten production by 3 years and save about $521 million.

Attainment of Product Knowledge

As of January 2012

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 Maturity

According to the program office, the JASSM-ER's five critical technologies—the engine lube system, engine system, fuse, low observable features, and global positioning system—are mature and have been tested in a realistic environment using a production-representative test missile.

Design Maturity

The JASSM-ER's design appears stable and the program seems to have overcome past reliability issues. The number of JASSM-ER configuration changes has decreased over time and, according to the program office, there was only 1 major configuration change and 16 minor configuration changes in the last year, 1 of which was related to the missile's reliability. In addition, according to program officials, the missile's design has been proven in testing; 10 out of 11 flight tests have been successful.

Despite the JASSM-ER's initial operational test success, testing has been put on hold because of problems with the missile's engine. An engine oil leak was discovered in December 2011 and all engines used in the operational test program were returned to the manufacturer to have corrective actions installed. These corrective actions will cause a 3- to 4-month delay in operational testing. However, program officials are optimistic that the program's full-rate production decision will not be affected because the full-rate decision is not scheduled until June 2013.

Production Maturity

The JASSM-ER entered production in January 2011 with processes that had been demonstrated, but were not in control. Prior to the production decision, the Air Force assessed that the JASSM-ER's manufacturing readiness was at the level recommended by DOD guidance for the start of low-rate production. However, the program's manufacturing readiness level did not indicate that its production processes were in statistical control. The program does not collect data on its critical manufacturing processes because the program was initiated using a total system performance responsibility arrangement, but the contractor does share some manufacturing data with the program office to prove it is meeting the missile's specification requirements. The contractor has implemented a process verification program with suppliers for the baseline missile to ensure that proper production processes are being followed. Program officials stated that the process verification program is not a contractual requirement, but rather a technique the contractor considers a best practice. According to program officials, process verification will also be used on the JASSM-ER.

Other Program Issues

Program officials stated that a combatant command has requested that more JASSM-ER missiles be delivered earlier than planned. To accommodate this request, program officials explained that JASSM-ER is scheduled to receive additional funding starting in fiscal year 2016 to pay for an additional 150 missiles per year. This rate increase may allow the program to shorten the production schedule by 3 years and save about $521 million. To attain these savings, program officials said the missile will need to reach its economic order quantity of 360 missiles per year by 2016 and continue at that production rate through the end of its production schedule.

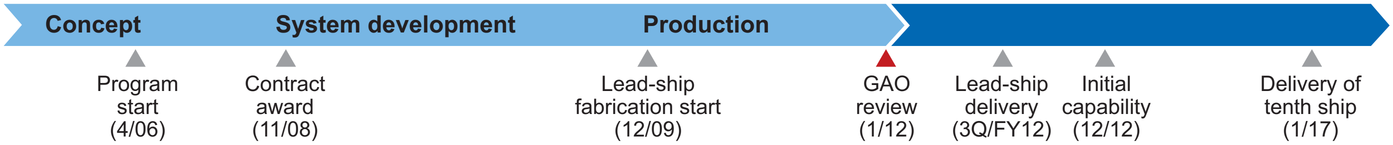
Program Office Comments

In commenting on a draft of this assessment, Air Force officials stated the JASSM-ER engine oil leak anomalies were identified in the production facility during missile assembly. Program office and Air Force testers jointly determined that the most-prudent course of action would be to delay operational testing until the issue could be solved. A root cause and corrective action have been identified and all operational testing and future production missiles will include the corrective actions. Operational testing is expected to resume in June 2012, with no risk to accomplishing full-rate production in June 2013. The Air Force also provided technical comments, which were incorporated as appropriate.

Joint High Speed Vessel (JHSV)

JHSV is a joint Army and Navy program to acquire a high-speed, shallow-depth vessel for rapid intratheater transport. The ship, which is based on a commercial design, will be capable of operating without relying on shore-based infrastructure. The program received approval to build 18 ships in October 2008, including 10 in low-rate initial production. Nine of the 10 vessels are under contract and two are under construction. The lead ship was scheduled for delivery in December 2011 and will now be delivered in spring 2012.

Source: Austal USA.



Program Essentials

Prime contractor: Austal USA
Program office: Washington, DC
Funding needed to complete:
- R&D: $23.0 million
- Procurement: $2,202.8 million
- Total funding: $2,225.9 million
- Procurement quantity: 11

Program Performance (fiscal year 2012 dollars in millions)

	As of 02/2009	**Latest 12/2010**	**Percent change**
Research and development cost	$128.4	$138.0	7.4
Procurement cost	$3,507.9	$3,536.1	0.8
Total program cost	$3,636.4	$3,674.1	1.0
Program unit cost	$202.020	$204.116	1.0
Total quantities	18	18	0.0
Acquisition cycle time (months)	48	50	4.2

The JHSV program began lead-ship fabrication in December 2009 with its critical technologies mature, but without a stable design. Only 9 of the ship's 44 design zones were complete in the three-dimensional product model. According to program officials, all 44 design zones were completed 9 months later in September 2010. The lead ship was launched in September 2011; however, according to the shipbuilder's data, the cost and schedule of the ship have been affected by an increase in the ship's weight. According to the Navy, delivery of the lead ship was to occur in December 2011 and will now occur in the spring of 2012. According to program officials, the Navy is reviewing the number of JHSVs required for future operations, and program quantities could change.

Attainment of Product Knowledge

As of January 2012

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

JHSV Program

Technology and Design Maturity

The JHSV program began lead-ship fabrication in December 2009 with all 18 of its critical technologies mature and demonstrated in a realistic environment, but without a stable design. Only 9 of the ship's 44 three-dimensional design zones were complete. This level of maturity falls short of GAO's best practices, which call for achieving a complete and stable three-dimensional product model before construction begins to minimize the risk of design changes and the subsequent costly rework and out-of-sequence work these changes can drive. According to program officials, all 44 zones were completed in September 2010, 9 months after fabrication began. However, as of August 2011, the American Bureau of Shipping had not yet completed acceptance of the JHSV design because some drawings that support functional and structural design were still outstanding.

Production Maturity

According to program officials, the JHSV program does not use critical manufacturing processes to measure production maturity. Instead, it monitors quality metrics of specific trades such as welding, monitors the contractor's earned value management data, and measures the current schedule against the production schedule. Additionally, the program demonstrated its manufacturing processes by building one of the ship's modules in the shipbuilder's new manufacturing facility. The lead ship was launched in September 2011 and, according to program officials, was 90 percent complete at that time. Construction of the second ship began September 2010, and was about 25 percent complete as of August 2011. According to shipbuilder data, a significant increase in the weight of the ship has negatively affected its construction cost and schedule by requiring additional material, production and engineering work, and design efforts. According to the Navy, delivery of the lead ship has been delayed and will now occur in the spring of 2012.

Austal USA, the shipyard that is constructing JHSV, is also building one version of the Littoral Combat Ship. According to officials, as a result of corrosion found in the water jet propulsion area of that ship, the JHSV program has conducted corrosion reviews and is applying the lessons learned from the Littoral Combat Ship to mitigate the potential for corrosion.

Other Program Issues

As a result of discussions with the Army in December 2010, the Navy assumed the role of life cycle manager and will operate all current and future JHSVs, including the five planned for procurement by the Army, on all missions. According to program officials, a requirements study is intended to determine the total quantity of JHSVs needed to support operations for both military services. The December 2010 selected acquisition report for the JHSV program lists a total quantity of 18 ships, including the 5 Army vessels; however, the Navy's May 2011 30-year shipbuilding plan lists a total of 21 ships.

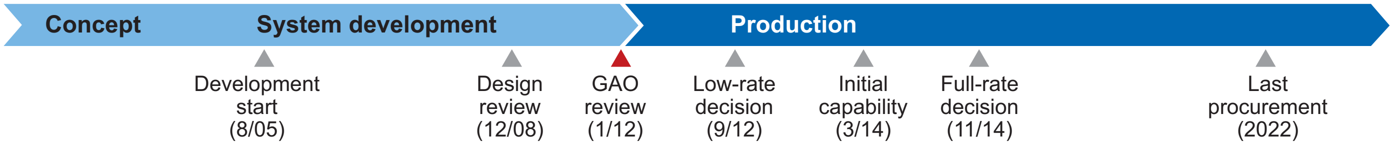
Program Office Comments

In commenting on a draft of this assessment, the Navy stated that the JHSV design is based on existing commercial platforms, and the design was 90 percent complete at the start of construction. The Navy further stated that GAO's best practices notwithstanding, sufficient production information from the two-dimensional design drawings and three-dimensional model has been developed to support production. Significant production risk has been avoided by implementing proven commercial production design and technology, ensuring stable requirements, minimizing change, and through pursuit of cost reduction and efficiency. In addition, the President's Budget for Fiscal Year 2013 reduced the total number of ships to be procured to 10. The Navy also provided technical comments, which were accounted for as appropriate.

Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS)

The Army's JLENS is designed to provide over-the-horizon detection and tracking of land-attack cruise missiles and other targets. The Army is developing JLENS in two spirals. Spiral 1 is complete and served as a test bed to demonstrate the concept. Spiral 2 will utilize two aerostats with advanced sensors for surveillance and tracking, as well as mobile mooring stations, communication payloads, and processing stations. JLENS will provide surveillance and targeting support to other systems, such as Patriot and Standard Missile-6. We assessed Spiral 2.

Source: U.S. Army.



Program Essentials

Prime contractor: Raytheon
Program office: Redstone Arsenal, AL
Funding needed to complete:
  R&D: $634.1 million
  Procurement: $5,199.4 million
  Total funding: $5,948.7 million
  Procurement quantity: 14

Program Performance (fiscal year 2012 dollars in millions)

	As of 08/2005	Latest 12/2010	Percent change
Research and development cost	$2,005.5	$2,523.2	25.8
Procurement cost	$4,588.7	$5,199.4	13.3
Total program cost	$6,665.9	$7,857.8	17.9
Program unit cost	$416.619	$491.112	17.9
Total quantities	16	16	0.0
Acquisition cycle time (months)	97	103	6.2

According to program officials, JLENS will enter production in September 2012 with mature technologies, a stable design, and proven production processes. Early problems with the software for the system's fire control radar—a critical technology—delayed the program's entry into developmental test and put the production decision date at risk. The JLENS design appears stable and some key production planning and test activities are complete, but the potential for design changes remains until the maturity of key components has been demonstrated and they have been successfully integrated and tested. In September 2010, an aerostat accident resulted in the loss of one of the JLENS platforms. The accident, as well as recent system integration challenges, delayed the program's production decision by 6 months and resulted in a Nunn-McCurdy unit-cost breach of the significant threshold.

Attainment of Product Knowledge

As of January 2012

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

JLENS Program

Technology Maturity

JLENS entered system development in August 2005 with only one of its five critical technologies mature. Two additional technologies—the communications processing group and platform—are now mature, and the program expects to demonstrate the fire control radar and surveillance radar in a realistic environment before production begins. Many of the JLENS radar technologies have legacy components. However, sensor software items related to signal processing, timing, and control, as well as element measurement, are not yet mature and problems have surfaced in software verification testing. Program officials said a decision to use newer technology introduced unexpected problems that could delay demonstration tests and the integration of both the radars' components.

Design Maturity

The JLENS design appears stable, but the potential for design changes will remain until key JLENS components have been integrated and tested. The recently resolved software problems associated with the fire control radar indicate that the system may still be immature and is at risk of not meeting system performance requirements. These issues could further delay planned tests, as well as the program's production decision. Although the program has had some success, including the first flight demonstration of the aerostat in August 2009, the program must still complete a series of tests integrating the sensors and processing station. An aerostat accident in September 2010 resulted in only minor damage to the mobile mooring station, but the aerostat and associated avionics and electronics were destroyed and important tests to assess the maturity of the system's design had to be postponed. In addition, the Army deployed one aerostat and mobile mooring station for combatant command exercises for the warfighter, which removed an important test asset from the program.

Production Maturity

The JLENS program projects that JLENS will enter production in September 2012 with all 15 of its critical manufacturing processes mature and stable. According to the program office, 12 of the program's critical manufacturing processes are currently in control. The JLENS program has also completed a number of key activities that are essential to effective production management, including updating its manufacturing plan and addressing areas such as supplier capabilities and risks, cost, quality control, materials, producibility, and workforce skills.

Other Program Issues

The JLENS program is working to address several risks that could affect the program's cost, schedule, and performance. First, due to the aerostat accident, JLENS program officials estimate a program effect of $8 million to $10 million. Second, schedule effects resulting from resolution of problems with the fire control radar software are expected to delay several key tests and put the program's production decision at risk. Third, the program experienced a Nunn-McCurdy unit-cost breach of the significant threshold and expects that integration and test delays could further increase costs. Finally, the JLENS program could be affected by alignment with the Army's Integrated Air and Missile Defense program. As part of the integrated strategy, the Army extended the system development phase for JLENS by 12 months.

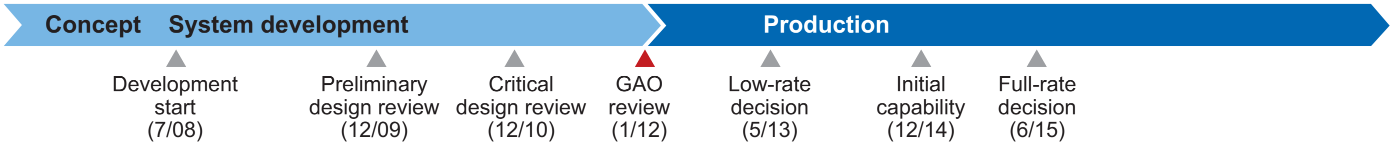
Program Office Comments

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

Joint Precision Approach and Landing System (JPALS)

JPALS Increment 1 is a Navy-led program developing a GPS-based aircraft landing system to replace current radar-based systems on its ships. It is designed to provide reliable precision approach and landing capability in adverse environmental conditions and improved interoperability. Increment 1A is the ship-based system and increment 1B will integrate JPALS with sea-based aircraft. Both increments are needed to provide a capability. We assessed increment 1A.

Source: Department of Defense.



Program Essentials

Prime contractor: Raytheon
Program office: Lexington Park, MD
Funding needed to complete:
  R&D: $183.9 million
  Procurement: $222.7 million
  Total funding: $406.6 million
  Procurement quantity: 26

Program Performance (fiscal year 2012 dollars in millions)

	As of 07/2008	Latest 08/2011	Percent change
Research and development cost	$792.1	$753.5	-4.9
Procurement cost	$213.2	$222.7	4.4
Total program cost	$1,012.3	$983.3	-2.9
Program unit cost	$27.359	$26.575	-2.9
Total quantities	37	37	0.0
Acquisition cycle time (months)	75	77	2.7

The JPALS program completed its critical design review in December 2010, but did not demonstrate that the design can perform as expected. As a result, the risk of design and software changes remains. JPALS functionality is software-based. According to program officials, the program has completed software qualification testing for four of five JPALS subsystems. Completion of testing of the ship processing software, which provides much of JPALS' functionality, has been delayed until March 2012 to incorporate an algorithm update. The program will begin integrated testing of a system prototype in January 2012 without this update. The program has delivered its first three engineering development models, with five more scheduled through 2012. Increment 1B, which integrates JPALS into sea-based aircraft, is planned to begin system development in 2012.

Attainment of Product Knowledge

As of January 2012

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 Program

Technology Maturity

JPALS Increment 1A began system development in July 2008 with its two critical technologies nearing maturity. Program officials expect both to be mature and demonstrated in a realistic environment by its May 2013 production decision. JPALS functionality is software-based, with over 850,000 lines of code expected in the final system as of August 2011—an increase of almost 57,000 lines of code since its December 2010 critical design review. According to program officials, all seven JPALS software blocks were completed in late August 2011 and the program has completed software qualification testing for four of five JPALS subsystems. Officials also noted that expected completion of testing for the ship processing software, which provides much of JPALS's functionality, has been delayed until March 2012 to allow the program time to integrate an updated version of an algorithm component. Any additional delays with this software testing could affect the JPALS test readiness review—a key program event—scheduled for April 2012.

Design Maturity

The JPALS design is currently stable, but it has not been demonstrated using a prototype to show that it will perform as expected. The risk of design and software changes will remain until the design shows it can meet requirements. The JPALS program held its critical design review in December 2010 and has released all of its expected design drawings to manufacturing. However, the program will not begin integrated testing of a system prototype until January 2012, and this testing will not include the ship processing software.

Production Maturity

The JPALS program plans to take steps to demonstrate the maturity of its manufacturing processes prior to beginning production. The program will demonstrate its manufacturing processes on a pilot production line and will demonstrate that the system will work as intended in a reliable manner by testing a fully configured production-representative prototype. The program accepted delivery of its first engineering development model in December 2010 and its second and third during 2011. Five additional models are scheduled for delivery through 2012, with initial models designated for land-based facilities testing and subsequent models for ship installation and testing. According to officials, the program's planned production decision was delayed from February 2013 to May 2013, primarily due to the availability of CVN 77 for ship-based testing.

Other Program Issues

The JPALS program has not updated key acquisition documents for increment 1A and 1B. When increment 1A was approved to enter system development in 2008, the Under Secretary of Defense for Acquisition, Technology and Logistics stated that its test and evaluation master plan should be updated prior to its preliminary design review, which was held in December 2009. Program officials stated that they have revised the plan, and expect it to be finalized by the program's test readiness review. Increment 1B is scheduled to enter system development in 2012, but the program does not currently have an approved acquisition strategy.

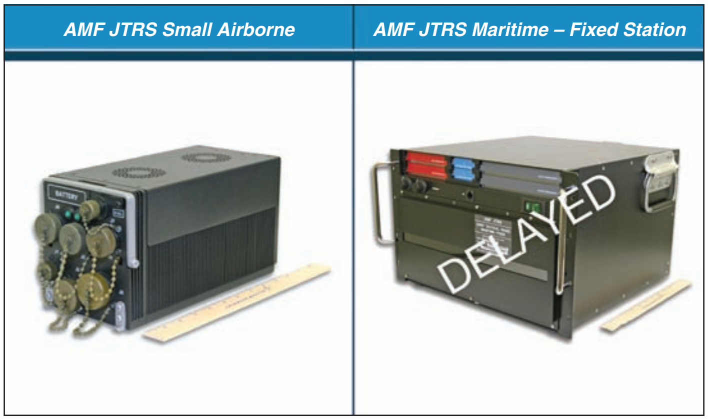
The increment 1A program will integrate JPALS onto 20 existing ships; incorporating JPALS on new ships under construction is the responsibility of those respective programs.

Program Office Comments

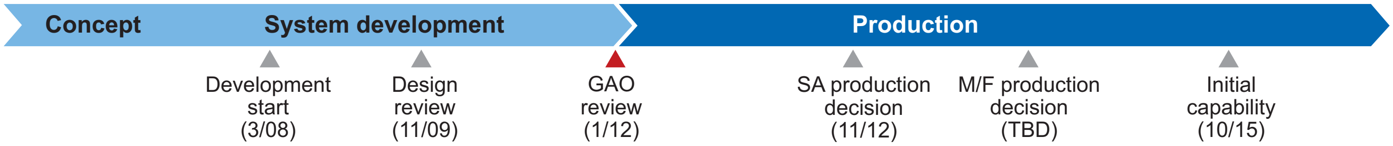
In commenting on a draft of this assessment, the JPALS program office noted that increment 1A is currently preparing for entry into formal integrated testing. There have been no requirement changes, and the December 2010 critical design review concluded the program's technical baseline is stable, and performance, cost, and schedule risks are acceptable. All requests for action from the critical design review have been closed. The program completed early testing of the GPS subsystems on board LHD 1 in July 2011, mitigating several program risks prior to beginning formal testing. The program office received a production-representative ship system engineering development model in October 2011 and three functionally-representative avionics test kits in November 2011. To date, the program has continued to meet all cost, schedule, and performance thresholds. The program also provided technical comments, which were incorporated as appropriate.

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

DOD's JTRS program is developing software-defined radios that will interoperate with existing radios and increase communications and networking capabilities. The AMF program will develop radios and associated equipment for integration into nearly 160 different types of aircraft, ships, and fixed stations. The program was developing two radios based on a common architecture: a 2-channel small airborne radio and 4-channel maritime/fixed station radio. DOD has suspended development work on the 4-channel radio.



Source: Lockheed Martin.



Program Essentials

Prime contractor: Lockheed Martin
Program office: San Diego, CA
Funding needed to complete:
R&D: $593.7 million
Procurement: $6,203.8 million
Total funding: $6,797.5 million
Procurement quantity: 26,878

Program Performance (fiscal year 2012 dollars in millions)

	As of 10/2008	Latest 08/2011	Percent change
Research and development cost	$1,945.0	$1,957.0	0.6
Procurement cost	$6,209.0	$6,203.8	-0.1
Total program cost	$8,154.1	$8,160.8	0.1
Program unit cost	$.301	$.301	0.1
Total quantities	27,102	27,102	0.0
Acquisition cycle time (months)	80	91	13.8

The program office reported quantities in terms of channels rather than radios.

The AMF JTRS program plans to enter production in November 2012, but it remains at risk for late and costly design changes until its critical technologies have been demonstrated in a realistic environment and other risks have been resolved. Growth in the processing requirements for one key AMF JTRS waveform—the wideband networking waveform—could require a hardware redesign. However, the program will not be able to determine whether one is needed until summer 2012 when the contractor demonstrates the waveform on an engineering development model. The AMF JTRS program has been directed by the Under Secretary of Defense for Acquisition, Technology and Logistics to restructure and delay further development of the maritime/fixed station radio because of unacceptable schedule delays and cost growth. Program officials are currently preparing a restructure plan.

Attainment of Product Knowledge

As of January 2012

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 Maturity

DOD approved the AMF JTRS program for entry into system development in March 2008 with all five of its critical technologies nearing maturity. According to the program, the maturity of these technologies has not changed. The program will not conduct a technology readiness assessment prior to the small airborne radio's production decision, as previously planned, because it is no longer required by DOD.

Design Maturity

The AMF JTRS design is currently stable; however, the program remains at risk for design changes until its critical technologies have been demonstrated in a realistic environment and other risks have been resolved. AMF JTRS' ability to meet its performance requirements is dependent on waveforms from the JTRS Network Enterprise Domain program. Growth in the processing requirements for one key AMF JTRS waveform—the wideband networking waveform—could result in design changes. According to program officials, the issue can be addressed by either making the waveform run more efficiently on the radio through software changes—the preferred solution—or by introducing a more-capable processor into the radio, which would require a hardware redesign. The program will not be able to determine whether the waveform's processing requirements can be reduced enough through efficiency gains until the contractor demonstrates the waveform on a small airborne engineering development model. There is a risk the delivery of the hardware for these models will be delayed. According to program officials, the Navy's Operational Test and Evaluation Force will conduct an operational assessment of the small airborne radio in preparation for its production decision, which is scheduled for November 2012.

According to the program office, AMF JTRS is on track to receive its security certification from the National Security Agency in early fiscal year 2013, but it will require an additional certification for its next software build, which includes functionality related to two key waveforms.

Production Maturity

The AMF JTRS program plans to begin production in November 2012 with manufacturing processes that have been demonstrated, but are not in control. A joint government-contractor assessment team has conducted manufacturing readiness level assessments—which include assessing statistical process controls—at each manufacturing site. The program's projected level of manufacturing readiness indicates that not all statistical process controls will be in place at the start of production. Program officials reported that the prime contractor qualified a second manufacturing source.

Other Program Issues

In September 2011, the Under Secretary of Defense for Acquisition, Technology and Logistics directed that the AMF JTRS program be restructured because of unacceptable schedule delays and cost growth. The development of the maritime/fixed station radio was delayed and the Joint Requirements Oversight Council was requested to reconsider the requirement. According to the program, the military services have agreed that the small airborne radio can meet the maritime/fixed station requirements. In addition, the program was directed to restructure the AMF JTRS contract to reduce the government's cost risk for completing development of the small airborne radio and limit work to key waveforms.

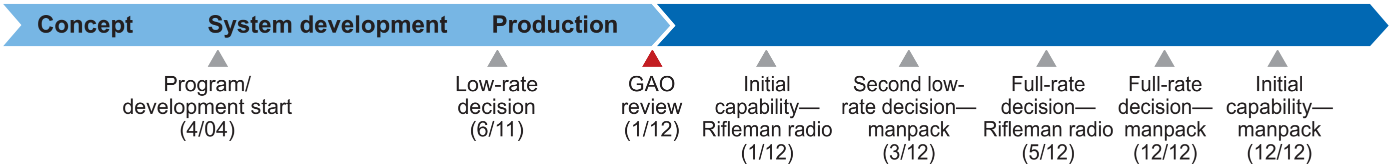
Program Office Comments

In commenting on a draft of this assessment, AMF JTRS program officials provided technical comments, which were incorporated as appropriate.

Joint Tactical Radio System (JTRS) Handheld, Manpack, and Small Form Fit (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 four radios: the Rifleman radio and small form fit radio D for unclassified use and the manpack radio and small form fit radio B for use in a classified domain. A subset of the manpack radios will be interoperable with the Mobile User Objective System (MUOS), a satellite communication system that will support radio terminals worldwide.

Source: General Dynamics C4S.



Program Essentials

Prime contractor: General Dynamics C4 Systems, Inc.
Program office: San Diego, CA
Funding needed to complete:
  R&D: $352.5 million
  Procurement: $7,022.1 million
  Total funding: $7,374.6 million
  Procurement quantity: 264,019

Program Performance (fiscal year 2012 dollars in millions)

	As of 05/2004	Latest 11/2011	Percent change
Research and development cost	$544.7	$1,272.3	133.6
Procurement cost	$9,492.8	$7,085.7	-25.4
Total program cost	$10,037.5	$8,357.9	-16.7
Program unit cost	$.031	$.031	1.0
Total quantities	328,674	270,951	-17.6
Acquisition cycle time (months)	85	104	22.4

The JTRS HMS program entered production in June 2011 without demonstrating or assessing the maturity of all its critical technologies and with a lower level of manufacturing readiness than recommended by guidance. According to the program, its radio designs are stable; however, the program is still making software changes, and reliability and heat-related issues were identified in a June/July 2011 manpack test event. Manpack production was initially limited to 100 radios because of concerns about its maturity and performance in testing. A second production decision is expected for the manpack radio in March 2012. The estimated cost of the program has increased by $3.5 billion from what the program reported in 2010 as quantities increased to meet military service needs and to fulfill some of the requirements of the cancelled JTRS Ground Mobile Radios program.

Attainment of Product Knowledge

As of January 2012

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

The JTRS HMS Rifleman radio entered production in June 2011 without demonstrating the maturity of one of its critical technologies—the soldier radio waveform—in a realistic environment. The program office does not expect the assessment of the manpack radio’s four critical technologies to be completed until April 2012.

Design Maturity

According to the JTRS HMS program, its radio designs are stable; however, the program is still demonstrating its critical technologies, making software changes, and addressing reliability and heat-related issues. The National Security Agency (NSA) has requested that the program modify some of its software code as part of its certification process. NSA certification, which is required due to JTRS’s information-assurance needs, was expected to be complete for both radios by the end of 2011. Additionally, reliability and heat-related issues were identified in June/July 2011 manpack testing. Program officials attributed the problems to poor training of radio operators and do not anticipate that design changes will be needed to address them. The Under Secretary of Defense for Acquisition, Technology and Logistics has stated that the reliability and heat issues are significant risks for the manpack and limited its initial procurement to 100 radios. A second production decision is planned for March 2012 followed by operational testing in May 2012. The Rifleman radio also fell short of its reliability requirement in testing conducted in early 2011. However, according to program officials, the radio’s performance was consistent with its reliability growth plan and they expect the radio will exceed its reliability requirements during operational testing, which is expected to be complete by February 2012.

Production Maturity

The JTRS manpack and Rifleman radios entered production in June 2011 at a lower level of maturity than DOD’s manufacturing readiness level deskbook recommends. However, the program did demonstrate the production process for the Rifleman radio. According to the program office, the maturity of JTRS HMS manufacturing processes have been steadily increasing, so processes once deemed critical are now considered either key or standard processes.

Other Program Issues

The HMS program has experienced several changes to the number and types of radios it plans to buy since the start of development. Initially, the program planned to buy 328,674 radios at a cost of $10 billion. In 2010, the number of radios was 215,961 and the cost was $4.9 billion. In 2011, quantities and cost increased to 270,951 and $8.4 billion to accommodate requests for more radios from the military services and to fulfill some of the requirements of the cancelled JTRS Ground Mobile Radios program. At the same time, the program stopped developing two small form fit radios and the 2-channel handheld radio. Unit costs have increased for the remaining small form fit and manpack radios, and could continue to grow for future manpack variants. While the program office expects that competition will lower the procurement unit cost, program officials noted that delays in the MUOS program will likely have negative effects on the manpack radio’s research and development cost and schedule. According to program officials, congressional funding reductions in fiscal year 2012 will also delay future releases of the manpack radio—including the MUOS-capable variant—and reduce planned radio purchases.

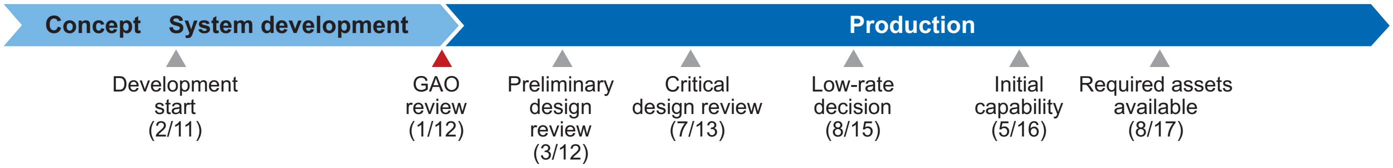
Program Office Comments

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

KC-46 Tanker Modernization Program

The KC-46 tanker program is the first of three planned phases to replace the Air Force's fleet of KC-135 tankers, which have been its primary aerial refueling aircraft for more than 50 years. The initial purchase of 179 KC-46 aircraft is intended to replace roughly one-third of the KC-135 fleet's current capability. In addition to aerial refueling, the aircraft are being designed as a multirole platform supporting global attack, airlift, aircraft deployment, special operations, aeromedical evacuation, and combat search and rescue.

Source: © 2011 Boeing. All rights reserved.



Program Essentials

Prime contractor: Boeing
Program office: Wright-Patterson AFB, OH
Funding needed to complete:
  R&D: $6,055.9 million
  Procurement: $33,502.6 million
  Total funding: $43,283.6 million
  Procurement quantity: 175

Program Performance (fiscal year 2012 dollars in millions)

	As of 08/2011	Latest 08/2011	Percent change
Research and development cost	$6,899.4	$6,899.4	0.0
Procurement cost	$33,502.6	$33,502.6	0.0
Total program cost	$44,127.2	$44,127.2	0.0
Program unit cost	$246.520	$246.520	0.0
Total quantities	179	179	0.0
Acquisition cycle time (months)	78	78	0.0

According to the Air Force, the development risk for the KC-46 is low to moderate because it will utilize a commercial derivative aircraft and maturing technologies; the integration of military software and hardware with the aircraft is the primary risk. The KC-46 tanker program entered system development in February 2011 with its three critical technologies nearing maturity. The program was granted a waiver to enter development without conducting a preliminary design review, but the program plans to hold this review in March 2012. The program also plans to have a stable design by its July 2013 critical design review. The KC-46 program is using a fixed-price incentive contract for development with options for production. The program office noted that stable requirements and funding will be key to mitigating potential cost growth.

Attainment of Product Knowledge

As of January 2012

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-46 Program

Technology Maturity

According to an independent technology readiness assessment, KC-46 entered system development with its three critical technologies nearing maturity. These technologies are a three-dimensional display to monitor and enable aerial refueling activities, and two types of software being developed to increase situational awareness and enable automatic aircraft rerouting to avoid potential threats. The integration of military hardware and software on the KC-46 aircraft's commercial derivative airframe has been identified as the primary technical risk for the program. Other technical risks include software development and the redesign of wing aerial refueling pods. In addition, the Federal Aviation Administration will have to certify both the Boeing 767-2C airframe and KC-46 tanker for air worthiness.

Design Maturity

The KC-46 tanker is a commercial derivative aircraft estimated to be 80 percent common with the Boeing 767 family of commercial platforms in terms of the airframe, and about 80 percent common with other Boeing commercial platforms in terms of system components. The KC-46 program did not require a technology development phase because it was assessed as having low to moderate development risk, and thus, did not hold a preliminary design review prior to beginning system development. The program received a waiver for this requirement and plans to hold this review in March 2012—about 13 months after development start. We have previously reported that holding a preliminary design review prior to development start can ensure requirements are well-defined and feasible. The program completed its system functional review—a predecessor to this review—in November 2011 resulting in no significant changes to program requirements. The program plans to demonstrate the system's design is stable and have 90 percent of KC-46 design drawings released by its projected July 2013 critical design review.

Production Maturity

The KC-46 program will not collect statistical process control data for critical manufacturing processes, but indicated that production maturity will be assessed using manufacturing readiness levels—a tool used to support assessments of manufacturing risks.

The significant concurrency between development, testing, and production activities poses a schedule risk for the KC-46 program. Following a successful initial production decision, the Air Force plans to exercise the first two production contract options. After the options are exercised, Boeing will be required to provide the Air Force with a total of 18 operationally ready aircraft 78 months after development contract award, which would be by August 2017. Further contract options are planned to continue through 2027. According to program officials, the government will hold Boeing accountable to the terms and conditions of the contract and seek consideration from Boeing if they do not perform to the contract requirements.

Other Program Issues

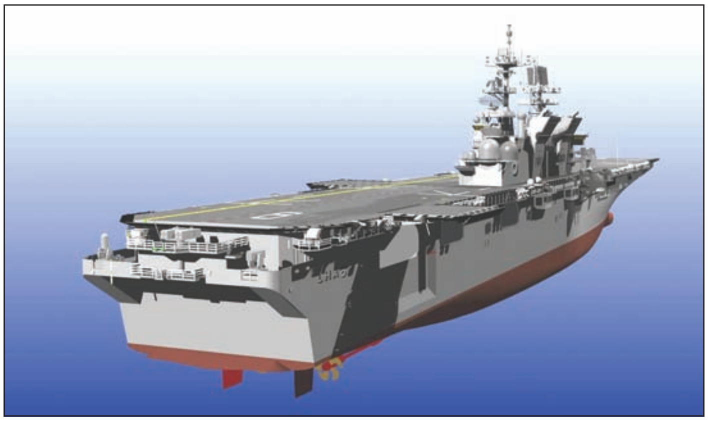
The Air Force awarded a $4.4 billion fixed-price incentive (firm target) contract to Boeing with a $4.9 billion ceiling price for four development aircraft with options for the remaining 175 planned production aircraft. The options establish firm-fixed pricing for low-rate initial production lots and not-to-exceed pricing for full-rate production lots. The program office cites stable requirements and funding as keys to mitigating potential cost growth.

Program Office Comments

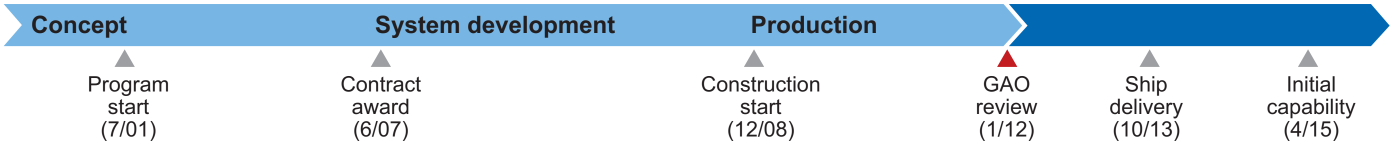
In commenting on a draft of this assessment, DOD stated the program mitigated the greatest KC-46 risk to the taxpayer—cost growth and open ended financial liability—by negotiating the competitive fixed-price incentive development contract with firm-fixed and not-to-exceed pricing for production. In addition, the program is mitigating the development schedule risk by maintaining tight oversight of contract execution to ensure Boeing delivers on its contract commitments. DOD also stated the KC-46 program is being managed in an event-based manner and the approval to begin production is not driven by a contractually required date. DOD will mitigate the risk posed by concurrency by ensuring that adequate testing is completed prior to the production decision in addition to the contract provision requiring Boeing to incorporate fixes to issues found during testing into production aircraft at no additional cost. DOD and the Air Force also provided technical comments, which were incorporated as appropriate.

LHA Replacement Amphibious Assault Ship

The Navy's LHA 6 class will replace the LHA 1 *Tarawa*-class amphibious assault ships. LHA 6 is a modified variant of the fielded LHD 8. It will feature enhanced aviation capabilities and is designed to support all afloat Marine Corps aviation assets in an expeditionary strike group. LHA 6 construction began in December 2008 and ship delivery is expected in October 2013. The LHA 6 class includes three ships. Navy officials expect to award the construction contract for LHA 7 by May 2012, with construction start planned for April 2013.



Source: U.S. Navy.



Program Essentials

Prime contractor: Huntington Ingalls Industries

Program office: Washington, DC

Funding needed to complete:
- R&D: $97.3 million
- Procurement: $5,627.9 million
- Total funding: $5,726.2 million
- Procurement quantity: 1

Program Performance (fiscal year 2012 dollars in millions)

	As of 01/2006	Latest 12/2010	Percent change
Research and development cost	$220.9	$350.9	58.8
Procurement cost	$2,959.2	$9,742.8	229.2
Total program cost	$3,180.2	$10,095.2	217.4
Program unit cost	$3,180.150	$3,365.053	5.8
Total quantities	1	3	200.0
Acquisition cycle time (months)	146	165	13.0

LHA 6 began construction in December 2008 with mature critical technologies, but a design that was only 65 percent complete. As of August 2011, the LHA 6 design was 98 percent complete and its construction was 52 percent complete. The shipbuilder is projecting an additional 6-month delay in the delivery of the ship, which is now expected in October 2013. According to the program office, this delay was caused by design quality issues—which have resulted in high levels of rework during construction—shortfalls in skilled-trade labor at the shipyard, problems implementing new shipbuilder business systems, and delays in receiving key materials. The LHA 6 program may also incur additional cost growth if postdelivery rework of the ship's deck is necessary to cope with the intense, hot downwash from the Joint Strike Fighter, which began shipboard testing in October 2011.

Attainment of Product Knowledge

As of January 2012

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 100 percent of design	○
• *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 America Class Program

Technology Maturity

All LHA critical technologies were mature when the program awarded its construction contract in June 2007. Although not considered critical technologies, the program has identified six key subsystems necessary to achieve LHA 6's full capabilities. Five of these subsystems are mature. The sixth, the Joint Precision Approach and Landing System, a Global Positioning System–based aircraft landing system, is still in development. LHA 6 can still meet its operational requirements without this system by using backup aviation control systems. The program office had also previously identified the machinery control system as a potential risk because the LHD 8 program, which is responsible for developing it, was experiencing delays in its development. However, according to program officials, the system's development, testing, and delivery are progressing on or ahead of LHA 6's schedule needs. Shipboard integration testing of the machinery control system is scheduled to begin in the second quarter of 2012.

Design and Production Maturity

The LHA 6 began construction in December 2008 with only 65 percent of its design complete, and subsequent design quality issues have caused a greater number of design changes than anticipated and high levels of rework during construction. The shipbuilder is also projecting an additional 6-month delay in the delivery of LHA 6, which is now expected in October 2013. As of August 2011, the LHA 6 design was 98 percent complete and its construction was 52 percent complete. The LHA 6's rework rate is more than twice that of the LHD 8—the last amphibious assault ship built—at the same stage of construction. According to program officials, LHA 6 has experienced a significant number of physical interference issues during construction that have required modifications, including ripping out of completed work, and caused work to stop at times. The program office attributes the high level of rework to insufficient quality checks of drawings prior to construction start. According to the program, shortfalls in skilled-trade labor at the shipyard, problems implementing new shipbuilder business systems, and delays in receiving key materials have also contributed to the projected delay in the delivery of the ship. Program officials said the manning situation at the shipyard has improved after the delivery of other Navy and Coast Guard ships.

LHA 7 will have a design that is very similar to LHA 6. The ship will include a new firefighting system and updates to the radar and the command, control, communications, computers, and intelligence systems. Design changes to LHA 8 are projected to be more significant because the Navy is expected to include a well deck on the ship, which would accommodate landing and attack craft, but negatively affect aviation capabilities such as fuel storage space.

Other Program Issues

LHA 6 may experience further cost growth due to issues related to the deployment of the Joint Strike Fighter. Specifically, postdelivery rework of the ship's deck may be necessary to cope with the heat from the aircraft's exhaust and downwash, which could warp the deck or damage deck equipment. In October 2011, the Navy began at-sea testing on the USS *Wasp* to determine how LHA 6 and other JSF-capable ships may need to modify their flight decks.

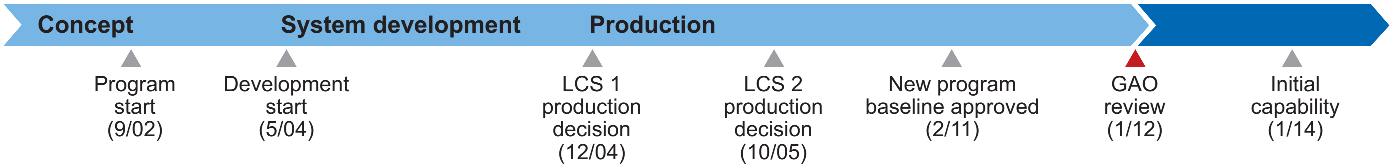
Program Office Comments

In commenting on a draft of this assessment, the Navy stated that LHA 6, awarded under a fixed-price contract, was 60 percent complete as of February 2012 and on track to be delivered in fiscal year 2014. The Navy also stated that LHA 6 experienced a higher rework rate than LHD 8 at the same stage of construction for two main reasons. First, the shipbuilder performed more work at an earlier phase by increasing the amount of preoutfitting in the ship compared to LHD 8. More rework is being experienced earlier in construction, where it is less expensive to perform. LHD 8 experienced the majority of rework at later construction phases. Second, the significant physical interference issues during construction have required modification. Shipbuilder quality performance is improving in electrical cable installation, hull joint fit-up, and weld quality, and several construction milestones, such as stern release, have been achieved ahead of schedule. Test procedure development is also ahead of schedule. The Navy also provided technical comments, which were incorporated as appropriate.

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 unique designs. In December 2010, the Navy changed its planned strategy of choosing one design for future ships and instead, subsequently awarded a contract for a block buy of up to 10 ships to both contractors. We assessed both seaframe designs.

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



Program Essentials

Prime contractor: Austal USA, General Dynamics, Lockheed Martin
Program office: Washington, DC
Funding needed to complete:
- R&D: $1,112.5 million
- Procurement: $25,001.1 million
- Total funding: $26,325.2 million
- Procurement quantity: 47

Program Performance (fiscal year 2012 dollars in millions)

	As of 05/2004	Latest 12/2010	Percent change
Research and development cost	$887.0	$3,520.1	296.9
Procurement cost	$471.6	$29,136.1	6,078.2
Total program cost	$1,358.6	$32,867.8	2,319.3
Program unit cost	$339.6	$597.596	76.0
Total quantities	4	55	1,275.0
Acquisition cycle time (months)	41	116	182.9

Cost data are for the seaframe only. The 2004 estimate corresponds with program initiation. It was pre–milestone B and did not reflect the full 55-ship program. Research and development funding includes detail design and construction of two ships.

The LCS program is entering a period of steady production and has demonstrated the maturity of most of its critical technologies; however, it continues to make design and production process changes. The Navy started construction of LCS 1 and 2 without a stable design and has had to incorporate design changes on follow-on seaframes. The Navy believes it has identified measures to address cracking on the LCS 1's superstructure and hull and corrosion issues on LCS 2 that can be achieved within the program's budget. DOD's Office of the Director, Cost Assessment and Program Evaluation, has stated that the program may be at risk for cost growth because its approved cost estimate reflects competitive pricing from recent contracts that may not materialize in the future.

Attainment of Product Knowledge

As of January 2012

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 19 critical technologies for both LCS designs are mature and have been demonstrated in a realistic environment. Three technologies—LCS 1’s overhead launch and retrieval system and LCS 2’s aluminum structure and trimaran hull—are nearing maturity. The LCS 1 overhead launch and retrieval system, which is essential to antisubmarine warfare and mine countermeasures missions, has moved weight equivalent to a mission system, but has not yet demonstrated its maturity by loading and offloading an actual mission module vehicle. Program officials stated that a test of the Remote Multi-Mission Vehicle with the launch and recovery system has not been scheduled and will depend on the availability of LCS 1 and the vehicle. Developmental testing for the vehicle is scheduled for 2013. In addition, program officials believe that LCS 2’s aluminum structure and trimaran hull are mature because the ship is operational. However, an April 2010 independent technology readiness assessment did not reach the same conclusion about the aluminum structure, in part because of the inability to assure a 20 year service life.

Design and Production Maturity

The Navy started construction of LCS 1 and 2 without a stable design and has had to incorporate design and production changes into follow-on seaframes. When the LCS 1 and 2 construction contracts were awarded, the basic and functional design of each seaframe were respectively only 20 percent and 15 percent complete. Construction began 1 to 2 months following these contract awards. This concurrent design-build strategy ultimately led to increases in construction costs.

LCS 1 has been in operation for about 3 years and the Navy has discovered cracks in the superstructure and hull. The program office indicated that the cracks occurred either in high stress areas on the ship or due to workmanship issues, such as welding deficiencies. Program officials stated that all cracks have been fixed and design changes and improved production processes, such as improving accessibility in welding areas, are being developed. The design changes, which decrease the stress on parts of the ship, will also be made on LCS 3, which is almost complete, as well as future seaframes. The Navy also reported corrosion on LCS 2, which has been in operation for over a year, due to insufficient insulation between the aluminum hull and the steel water jet. The Navy plans to install a system to mitigate the deterioration of metals on LCS 2 and future seaframes. The Navy believes these measures are sufficient to address the cracking and corrosion issues and can be done within the program’s budget.

Other Program Issues

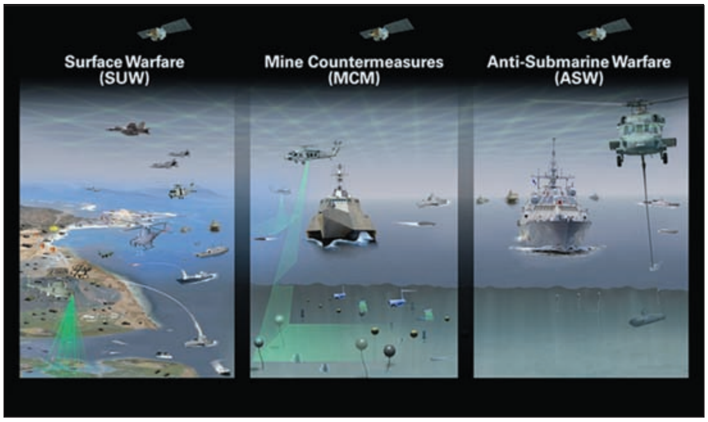
The LCS’s approved program baseline is based on a cost estimate that is lower than an independent cost estimate from the Office of the Director, Cost Assessment and Program Evaluation. The Under Secretary of Defense for Acquisition, Technology and Logistics stated that the approved cost estimate is reasonable as it reflects the expectation that recent competitive pricing will continue for future contracts. The Director, Cost Assessment and Program Evaluation, expressed concern that this approach puts the program at risk for future cost growth if these savings do not materialize.

Program Office Comments

In commenting on a draft of this assessment, the Navy stated that it has retired the increased construction costs associated with the concurrent design/build period. The Navy noted that due to the complex nature of ship design and construction, lead ships generally have design changes that are incorporated into follow-on ships as a result of extensive testing and ship underway lessons learned. That is common practice in ships, even with a stable baseline, as evidenced by changes incorporated in the DDG 51 Class. LCS 3 and 4 have experienced minimal design changes and reflect learning, with both shipbuilders investing in their shipyards. LCS 3 is 99 percent complete and will deliver in June 2012. LCS 4 was about 80 percent complete at launch and was christened in January 2012. LCS 5 completed a detail design review and a production readiness review and its fabrication began in August 2011. LCS 6 followed suit and started fabrication in August 2011. Technical comments provided by the Navy were incorporated as appropriate.

Littoral Combat Ship–Mission Modules

The Navy's Littoral Combat Ship (LCS) will perform mine countermeasures (MCM), surface warfare (SUW), and antisubmarine warfare (ASW) missions using mission modules. Modules include weapons and sensors operating from MH-60 helicopters and unmanned vehicles, which will be launched and recovered from both LCS seaframes. The mission modules program is separate from the LCS seaframe for management and reporting purposes. The Navy has defined increments of MCM, SUW, and ASW capability that it plans to deliver incrementally, over time.



Source: © Northrop Grumman Corporation.

Program Essentials

Prime contractor: Multiple
Program office: Washington, DC
Funding FY12 to FY16:
  R&D: $657.4 million
  Procurement: $969.3 million
  Total funding: $1,626.7 million
  Procurement quantity: 18

Program Performance (fiscal year 2012 dollars in millions)

	As of 08/2007	Latest 09/2011	Percent change
Research and development cost	$491.8	$1,652.4	236.0
Procurement cost	$3,259.2	$1,228.0	-62.3
Total program cost	$3,751.0	$2,880.4	-23.2
Program unit cost	NA	NA	NA
Total quantities	64	65	1.6
Acquisition cycle time (months)	NA	NA	NA

Costs are from program start through fiscal year 2016. The program's cost estimate has been updated by the Navy and a baseline will be set after DOD's upcoming review of the program.

The MCM, SUW, and ASW mission modules, at full capability, require a total of 24 critical technologies, including sensors, vehicles, and weapons—none of which, at full capability, have been tested on board LCS in a realistic environment. In addition, some of the sensors, vehicles, and weapons that the Navy previously assessed as mature are being replaced because of poor performance or increasing costs. The Navy is continuing developmental testing but has yet to begin operational testing. The Navy has accepted delivery of two partially capable MCM and SUW mission modules, each, for a total of four. In 2012, the Navy plans to accept delivery of a total of three MCM and SUW mission modules and also plans to procure two more partially capable modules. The Navy plans to procure 24, and deliver 9, LCS seaframes by 2016, before delivering a single fully capable mission module.

Attainment of Product Knowledge

Projected as of January 2012

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 Modules Program

Mine Countermeasures (MCM)

The Navy has accepted delivery of two partially capable MCM mission modules and, in 2012, expects to accept delivery of a module and procure another module. The Navy plans to begin operational testing onboard LCS in 2012, but the contents of the MCM module are still changing to address cost and capability concerns. For example, the remote minehunting system (RMS), comprised of an underwater vehicle and sonar, experienced a Nunn-McCurdy unit-cost breach in 2009. Further, the Navy has found performance issues, in part because the equipment required to launch and recover the underwater vehicle is not reliable and sonar performance does not currently meet threshold requirements. Since the Navy already purchased 10 underwater vehicles and determined there is no better alternative, RMS will remain in the module. The Navy is currently executing a plan to improve its reliability and then plans to begin producing the upgraded RMS in 2015. The rapid airborne mine clearance system was initially part of the MCM module, but was removed because of performance problems when destroying below-surface mines. The Navy plans to replace it by 2017. The Navy has also removed the unmanned surface vehicle (USV) and unmanned influence sweep system from its upcoming mission module. The USV design does not meet requirements, requiring a 6-year effort to improve the system's capabilities. The Navy has also deferred delivery of two other MCM systems.

Surface Warfare (SUW)

The Navy has accepted delivery of two partial SUW modules, including two 30 millimeter guns and a prototype of an 11-meter small boat. In 2012, the Navy plans to accept delivery of two and procure one more partial module. The Navy has replaced the cancelled Non-Line-of-Sight Launch System—which had a proposed range of 21 nautical miles—with the Griffin missile, which according to officials, will initially have a range of 3 miles. The Navy will not incorporate a surface-to-surface missile that can meet the module's requirements until after 2017 following a full and open competition.

Antisubmarine Warfare (ASW)

In 2008, the Navy took delivery of one partially capable ASW module at a cost of over $200 million, but subsequently cancelled plans to continue procuring the module and is redesigning it. According to program officials, the new design includes a variable-depth sonar and towed array, unmanned aerial vehicle, helicopter, and torpedo countermeasure. These ASW technologies are in use by another navy, but they have not been adapted for use with LCS. In 2012, the Navy will begin engineering analysis of the new ASW module, followed by development start in 2013 and initial delivery in fiscal year 2016.

Other Program Issues

The Navy plans to purchase 24, and deliver 9, LCS seaframes by 2016; however, it will not have a single fully capable mission module at that time. As of September 2011, the program planned to conduct a key DOD review in January 2012; however, this review, which includes a program cost estimate and technology maturity assessment, has been delayed to an unspecified date in 2012.

Program Office Comments

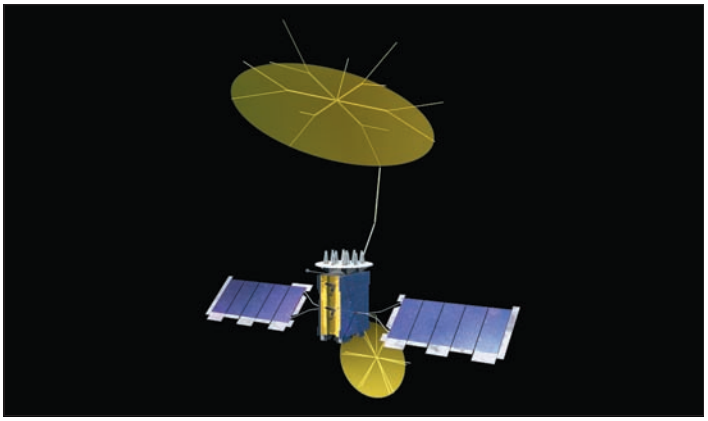
In commenting on a draft of the assessment, the program office did not concur with our assessment of the LCS Mission Modules; specifically with regard to the state of development and maturity of the mission modules. The program believes that recent testing has been very successful. For example, the MCM module has recently completed developmental and end-to-end testing to neutralize mines. The SUW module supported deployment of LCS 1 on missions that resulted in the capture of cocaine. From inception, the program has remained stable, fielding systems as they achieve the required level of maturity. The few systems experiencing issues are being replaced with alternative systems or are targets of increased focus and attention. The program also provided technical comments, which were incorporated as appropriate.

GAO Response

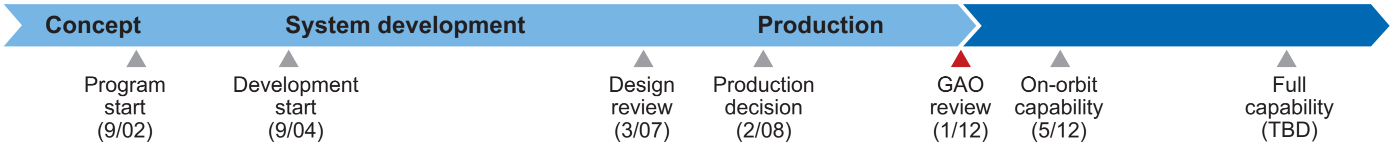
Major elements of each of the three mission modules have yet to be demonstrated and there are unknowns about their cost and performance. Until the program demonstrates these capabilities in a realistic environment, the program will be at increased risk of cost growth, schedule delays, and performance shortfalls.

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: $470.1 million
  Procurement: $1,125.1 million
  Total funding: $1,595.2 million
  Procurement quantity: 1

Program Performance (fiscal year 2012 dollars in millions)

	As of 09/2004	Latest 08/2011	Percent change
Research and development cost	$3,647.7	$4,218.3	15.6
Procurement cost	$3,035.0	$2,694.3	-11.2
Total program cost	$6,721.3	$6,978.2	3.8
Program unit cost	$1,120.222	$1,163.035	3.8
Total quantities	6	6	0.0
Acquisition cycle time (months)	90	116	28.9

The latest cost data do not reflect the current cost of the program. A new acquisition program baseline has not yet been approved.

The MUOS program's critical technologies are mature, its design is stable, and its manufacturing process maturity is increasing. The first satellite has been delivered and is expected to begin on-orbit operations in May 2012—26 months later than planned at development start. The delivery of MUOS capabilities remains time-critical due to the past operational failures of two UFO satellites. If the first satellite is launched as scheduled, the risk of UHF communications capabilities falling below required levels will be substantially reduced. However, users will not be able to utilize many MUOS capabilities until two MUOS satellites are in orbit and because of delays in the development and testing of a new waveform and fielding of user terminals. MUOS user terminal procurement and fielding are managed by separate programs.

Attainment of Product Knowledge

As of January 2012

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 critical technologies are mature, its design is stable, and its manufacturing process maturity is increasing. The first satellite has been delivered and four other satellites are being built. Despite some delays, system-level thermal vacuum testing—used to demonstrate the performance of the payload and spacecraft in a simulated space environment—has been completed for the first satellite. In addition, the design flaws that we reported on last year—including unwanted signal interference caused by UHF reflectors and the hinges that connect solar panels and booms in the solar array wing assembly—have been resolved. These components have been reworked and tested; final signal interference testing results were completed in November 2011. According to the program office, the production maturity of the first MUOS satellite is high. The program has experienced quality problems in the past that resulted in cost increases and schedule delays. However, the number of manufacturing defects on the space segment has decreased slightly over time as the maturity of the manufacturing process has increased. We could not assess whether MUOS critical manufacturing processes were in control because the program does not collect statistical process control data.

Other Program Issues

The first MUOS satellite has been delivered for a planned February 2012 launch. Current UHF communication capabilities are predicted to provide the required availability level until the first MUOS satellite begins on-orbit operations—planned for May 2012. The MUOS program has taken actions to address a potential capability gap caused by earlier, unexpected UFO satellite failures by activating dual digital receiver unit operations on a UFO satellite, leasing commercial UHF satellite services, initiating international partner agreements to share UHF satellite capacity, and planning to enhance digital receiver unit operations on the second through fifth MUOS satellites.

According to the program office, its top challenge is synchronizing deliveries of the MUOS space and ground segments with compatible Joint Tactical Radio System (JTRS) terminals. Launching the first MUOS satellite is important to sustain current UHF communications capability, but there is a risk that MUOS capabilities will be significantly underutilized because of delays in the JTRS program's development and delivery of the new MUOS waveform and radio terminals. Over 90 percent of the MUOS's planned capability is enabled by the new waveform and JTRS terminals, including increases in the amount of data that can be transmitted and the ability to transmit both voice and data. Operational testing of the JTRS terminals has been delayed to February 2014. An independent review team assessed potential options for completing development of the MUOS waveform and the plan forward is being finalized.

In 2009, a Navy-initiated review of the MUOS program found that while it was technically sound, its schedule was optimistic and its budget was inadequate. As a result, the program developed new cost and schedule baselines. The new baseline has been under revision since December 2009, but has not yet been approved.

Program Office Comments

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

MQ-4C Broad Area Maritime Surveillance (BAMS) Unmanned Aircraft System (UAS)

The Navy's MQ-4C BAMS UAS is intended to provide a persistent maritime intelligence, surveillance, and reconnaissance (ISR) capability even when no other naval forces are present. BAMS UAS will operate from five land-based sites worldwide. It will be part of a family of maritime patrol and reconnaissance systems that recapitalizes the Navy's airborne ISR assets. Follow-on increments of the program will add a signals intelligence capability and upgrade the system's communication relay. We assessed Increment 1.

Source: Northrop Grumman.

Program Essentials

Prime contractor: Northrop Grumman Systems Corporation
Program office: Patuxent River, MD
Funding needed to complete:
  R&D: $1,657.1 million
  Procurement: $9,413.9 million
  Total funding: $11,422.2 million
  Procurement quantity: 65

Program Performance (fiscal year 2012 dollars in millions)

	As of 02/2009	Latest 12/2010	Percent change
Research and development cost	$3,141.7	$3,245.6	3.3
Procurement cost	$9,323.4	$9,413.9	1.0
Total program cost	$12,847.6	$13,052.4	1.6
Program unit cost	$183.537	$186.463	1.6
Total quantities	70	70	0.0
Acquisition cycle time (months)	92	92	0.0

The BAMS UAS program's critical technologies are mature and its design is stable; however, the program does not plan to demonstrate that the design performs as expected until April 2012—more than a year after the critical design review. According to program officials, the second BAMS UAS system development aircraft, which will begin testing in 2012, will be the first aircraft with a full sensor suite and the air-to-air radar subsystem. In November 2011, the BAMS UAS program received approval to build three systems and ground stations, in part to demonstrate its manufacturing processes prior to its planned May 2013 production decision. According to program officials, the BAMS air vehicle is based on the Air Force's RQ-4B Global Hawk with some structural changes to the airframe, but none of these require significant changes to manufacturing processes.

Attainment of Product Knowledge

As of January 2012

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

BAMS UAS Program

Technology Maturity

The BAMS UAS program's critical technologies are mature. DOD and the Navy certified that all BAMS UAS technologies had been demonstrated in a relevant environment before the start of system development, and an April 2011 technology readiness assessment concluded that its one critical technology—a hydrocarbon sensor—was mature. This sensor is identical to one that has been developed for the Navy's P-8A program. The maturity of the BAMS air-to-air radar subsystem, which will enable its sense and avoid capabilities, has not been assessed.

Design Maturity

The BAMS UAS design is stable; however, the program does not plan to demonstrate the design performs as expected by testing an integrated prototype until April 2012—more than a year after the critical design review. According to the program office, 97 percent of the air vehicle's expected design drawings are releasable to manufacturing and all subsystem critical design reviews have been completed. The second BAMS UAS system development aircraft, which will begin testing in 2012, will be the first aircraft with a full sensor suite and the air-to-air radar subsystem.

The BAMS UAS program poses a significant software development challenge, utilizing nearly 8 million lines of code, of which more than 20 percent will be newly developed for the program. Program officials cited software development as a primary risk for one subsystem, the air-to-air radar, but noted that they still expect it to be ready for the program's planned operational assessment in 2013.

Production Maturity

In November 2011, the BAMS UAS program received approval to build three air vehicles and associated ground stations, in part to demonstrate its manufacturing processes prior to production. According to program officials, the program also plans to assess manufacturing maturity and risks, using manufacturing readiness levels, before its planned production decision in May 2013. The BAMS aircraft is based on the Air Force's Global Hawk RQ-4B, which is in production, and uses sensor components and entire subsystems from other platforms. There are some structural changes to the airframe, but none of these require significant changes to manufacturing processes.

Other Program Issues

The BAMS UAS program has not reported any negative effects as a result of past challenges in the Global Hawk program; however, we did not assess the effect of the proposed cancellation of the Global Hawk Block 30 program. According to the BAMS UAS program office, the performance and reliability issues experienced by the Global Hawk during operational testing have already been addressed for the BAMS UAS. In addition, the BAMS UAS program has reported to the Navy on the potential cost effects of reduced Global Hawk procurements, which occurred after that program experienced a Nunn-McCurdy unit-cost breach of the critical threshold in 2011. Despite changes to the Global Hawk program, the BAMS UAS program is continuing to investigate potential areas of commonality with it, including a common ground control station architecture, a consolidated maintenance hub, and colocated basing for both UASs abroad. The Navy acquired three additional Global Hawk Block 10 aircraft divested by the Air Force. These aircraft will be used to provide additional parts support to maintain the BAMS demonstrator capability supporting overseas operations until BAMS UAS reaches initial operating capability scheduled for 2015.

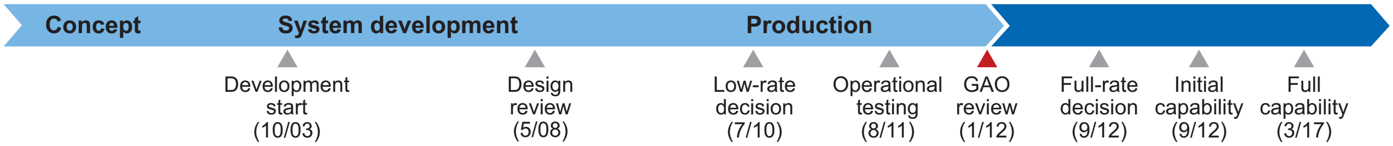
Program Office Comments

In commenting on a draft of this assessment, the Navy stated that, while the software development, system integration, and integrated test efforts pose challenges for the BAMS UAS program in the coming years, proactive risk mitigation and detailed cost and schedule management to this point have provided the basis for successful completion of upcoming program milestones. According to officials, the program benefits from strong support within the Department of the Navy, fills a tremendous need for intelligence, surveillance, and reconnaissance capability, and is on track for initial operational capability in fiscal year 2016. Additionally, the Navy provided technical comments, which were incorporated as appropriate.

Navy Multiband Terminal (NMT)

The Navy's NMT is a next-generation maritime military satellite communications terminal that will be installed in existing ships, submarines, and shore sites. NMT is designed to work with the Air Force's Advanced Extremely High Frequency (AEHF) satellite system to provide protected and survivable satellite communications to naval forces. Its multiband capabilities will also enable communications over existing military satellite communication systems, such as Milstar, Wideband Global SATCOM, and the Defense Satellite Communications System.

Source: © 2008 Raytheon.



Program Essentials

Prime contractor: Raytheon
Program office: San Diego, CA
Funding needed to complete:
  R&D: $41.1 million
  Procurement: $992.6 million
  Total funding: $1,033.8 million
  Procurement quantity: 189

Program Performance (fiscal year 2012 dollars in millions)

	As of 12/2006	Latest 08/2011	Percent change
Research and development cost	$697.2	$666.2	-4.4
Procurement cost	$1,623.7	$1,214.4	-25.2
Total program cost	$2,321.0	$1,880.7	-19.0
Program unit cost	$6.970	$6.186	-11.2
Total quantities	333	304	-8.7
Acquisition cycle time (months)	107	107	0.0

The NMT program entered production in July 2010 with mature critical technologies, a stable design, and production processes that had been demonstrated, but were not in control. The program will complete a manufacturing readiness assessment to demonstrate its maturity prior to its full-rate production decision, targeted for September 2012. According to the program office, the number of design changes in fiscal year 2011 was greater than anticipated as a result of test failures. The NMT program's software lines of code also increased after the Navy added a capability to support communication with the Enhanced Polar System. NMT completed initial operational test and evaluation in August 2011, and DOD's independent test organization found that the system was operationally effective, but not operationally suitable because it did not meet certain reliability requirements during the test.

Attainment of Product Knowledge

As of January 2012

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

NMT Program

Technology Maturity

The NMT program's two critical technologies—a multiband antenna feed and monolithic microwave integrated circuit power amplifiers for Q-band and Ka-band communication frequencies—are mature.

Design Maturity

The NMT's design is stable and the program has released all of its expected design drawings. According to the program office, the number of design changes in fiscal year 2011 was greater than anticipated because two subassemblies were redesigned to address failures in testing. The overall effect of these changes on the program was minor. The NMT program's software lines of code have increased since the start of production because the Navy requested that the program add a capability to support communication with the Enhanced Polar System. Overall, software integration testing is over 95 percent complete with over 98 percent of the defects resolved.

Production Maturity

The NMT program office began production in July 2010 with processes that had been demonstrated on a pilot line, but were not in control. The program estimates that three of its five processes are now in statistical control. According to the program office, a production readiness review will be performed prior to the NMT's full-rate production decision, which is expected to occur in September 2012. The program will also complete a manufacturing readiness assessment to demonstrate that it is mature enough for full-rate production.

Other Program Issues

NMT completed initial operational test and evaluation in August 2011. The Navy's and DOD's independent test organizations found that NMT was operationally effective, but not operationally suitable because it did not meet certain reliability requirements. The program has identified corrective actions to address the shortfalls. As a result of the test findings, program officials stated they will extend low-rate production and delay the full-rate production decision from December 2011 to September 2012.

NMT is dependent on AEHF satellites to test its full range of capabilities. The first AEHF satellite was launched in August 2010; however, a satellite propulsion system anomaly delayed the satellite from reaching its planned orbit until October 2011. AEHF delays directly affect the ability of the NMT program to test its extended-data-rate communications capability. According to NMT program officials, risk-reduction testing was conducted using an advanced AEHF simulator; on-orbit testing was completed with Milstar satellites; and ground testing of low-, medium-, and extended-data-rate capabilities was done with the second AEHF satellite. The second AEHF satellite is expected to launch in April 2012, and follow-on operational testing, which will include on-orbit AEHF satellites, will begin in early fiscal year 2014. In the interim, program officials stated that fielded NMT systems can provide value by accessing existing satellite communication systems such as the Defense Satellite Communications System, Milstar, Wideband Global SATCOM, Interim Polar, and UFO satellite constellations. The realization of the NMT's full operational capability has been delayed 2 years to 2017 to better align with the warfighter's needs.

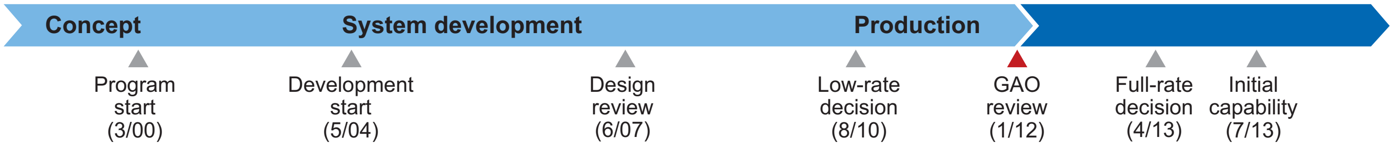
Program Office Comments

In commenting on a draft of this assessment, the Navy stated that the NMT program is in low-rate initial production, moving toward a full-rate production decision. The program will demonstrate the fixes for the shortfalls identified in initial operational test and evaluation through verification testing, including on operational platforms. The Navy further stated that NMT is committed to providing deployed naval commanders with assured access to secure, protected command and control and communication capabilities to support the exchange of warfighter-critical information. NMT will support the Navy's net-centric FORCEnet architecture and act as an enabler for transforming operational capability available to the warfighter. The Navy also provided technical comments, which were incorporated as appropriate.

P-8A Poseidon

The Navy's P-8A Poseidon is a Boeing commercial derivative aircraft that will replace the P-3C Orion. Its primary roles are antisubmarine warfare; antisurface warfare; and intelligence, surveillance, and reconnaissance. The P-8A is a part of a family of systems that share the integrated maritime patrol mission and support the Navy's maritime warfighting capability. The program plans to field capabilities in three increments. We assessed increment one and made observations on increment two.

Source: U.S. Navy.



Program Essentials

Prime contractor: Boeing
Program office: Patuxent River, MD
Funding needed to complete:
  R&D: $1,232.4 million
  Procurement: $20,087.9 million
  Total funding: $21,839.0 million
  Procurement quantity: 104

Program Performance (fiscal year 2012 dollars in millions)

	As of 05/2004	Latest 08/2011	Percent change
Research and development cost	$7,531.5	$8,215.3	9.1
Procurement cost	$23,365.2	$24,157.2	3.4
Total program cost	$31,034.3	$32,969.3	6.2
Program unit cost	$269.864	$270.240	0.1
Total quantities	115	122	6.1
Acquisition cycle time (months)	160	160	0.0

The P-8A entered production in August 2010 with mature technologies, a stable design, and proven production processes. The program is conducting its remaining development activities concurrently with production, which puts the program at increased risk of experiencing late and costly design changes. The number of design drawings has increased slightly in the last year to address deficiencies discovered during testing. The manufacturing processes for the P-8A airframe are proven. The processes for key aircraft subsystems have also been assessed as generally mature, although the program has experienced quality issues with some of them. The Navy has identified the execution of testing as a risk, which program officials stated has delayed the start of initial operational test and evaluation from April to June 2012. The program is taking steps to reduce this schedule pressure.

Attainment of Product Knowledge

As of January 2012

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

P-8A Program

Technology Maturity

The P-8A entered production in August 2010 with mature technologies. The current critical technology, the hydrocarbon sensor, has been tested in ground-based applications and program officials indicated that flight testing will occur in fiscal year 2012. The program also noted that it has begun flight testing the ESM digital receiver and the sonobuoy launcher, two technologies that were previously identified as being critical but are no longer designated as such based on their use in other platforms.

The P-8A program has been authorized to incorporate a set of capabilities initially planned as a separate increment into the baseline program primarily because these improvements will entail the integration of mature technologies into the aircraft.

Design Maturity

The program entered production with a stable design; however, system development efforts are continuing concurrently with production, putting the program at increased risk of late and costly design changes. The number of design drawings has increased slightly since August 2010 as a result of deficiencies discovered during testing. Program officials stated that they are still determining how to incorporate changes identified during developmental testing into the initial production aircraft, noting that the strategy will depend upon the availability of funding.

Production Maturity

The manufacturing processes for the P-8A have been proven. The program demonstrated its airframe manufacturing processes on a commercial line prior to entering into production. The manufacturing readiness levels associated with the P-8A's main subsystems indicate their processes are also generally mature, although the program has encountered quality issues with the on-board inert gas generator system and auxiliary fuel tanks, which are currently being addressed by the prime contractor. Delivery of the first production aircraft is scheduled for February 2012.

Other Program Issues

The P-8A airframe has been designated a commercial item. As a result, the contractor is not required to submit cost or pricing data to the government. Program officials stated that this designation has not affected recent contract negotiations, and the program negotiated a 10 percent lower unit cost on its second production contract. The commercial item designation has also generated concerns in the past from the Defense Contract Management Agency (DCMA) about the government's access to production facilities and its ability to conduct surveillance. However, DCMA has started reporting on aircraft quality at the Boeing commercial facility in Washington responsible for the wing, tail, aircraft assembly, and engine installation.

The operational assessment of the P-8A conducted prior to production start found that the system demonstrated the expected level of maturity, but it also identified a number of shortfalls, including sonobuoy and weapons deployment. The Director, Operational Test and Evaluation, noted that some of these shortfalls degraded mission performance, and, if not addressed, may pose a risk to the program successfully completing initial operational test and evaluation. The Navy and DCMA have also identified the execution of testing as a risk, which program officials stated has delayed the start of initial operational test and evaluation from April to June 2012. The program is focused on maintaining flight test execution rates while it pursues opportunities to reduce this schedule pressure.

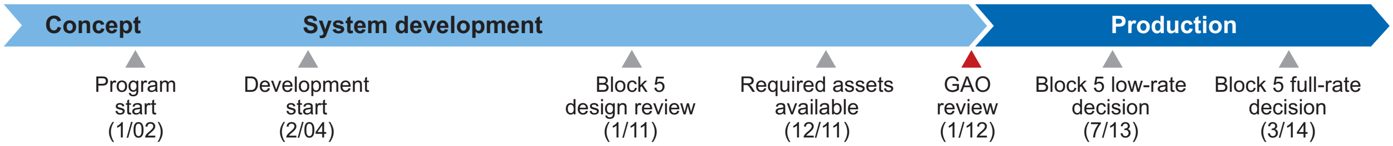
Program Office Comments

In commenting on a draft of this assessment, the Navy stated that the program continues to execute its test plan in preparation for the start of initial operational test and evaluation. Testing has been an identified risk as a result of inefficiencies in execution; however, extensive corrective actions have been implemented to manage this risk. Program officials said that although the corrective actions have improved the efficiency of test execution, the program has adjusted the start of initial operational test and evaluation from April 2012 to June 2012, which is still within the program's approved baseline. In addition, the program is working to capture, correct, and test deficiencies identified in testing and manage this risk. The Navy also provided technical comments, which were incorporated as appropriate.

Reaper Unmanned Aircraft System (UAS)

The Air Force's MQ-9 Reaper is a multirole, medium-to-high-altitude endurance unmanned aircraft system capable of flying at higher speeds and higher altitudes than its predecessor, the MQ-1 Predator A. The Reaper is designed to provide a ground-attack capability to find, fix, track, target, engage, and assess small ground mobile or fixed targets. Each system consists of four aircraft, a ground control station, and a satellite communications suite. We assessed the increment I block 5 configuration and made observations on block 1.

Source: U.S. Air Force.



Program Essentials

Prime contractor: General Atomics Aeronautical Systems, Inc.
Program office: Wright-Patterson AFB, OH
Funding needed to complete:
  R&D: $420.5 million
  Procurement: $7,962.6 million
  Total funding: $8,473.5 million
  Procurement quantity: 240

Program Performance (fiscal year 2012 dollars in millions)

	As of 02/2008	Latest 08/2011	Percent change
Research and development cost	$420.1	$920.3	119.1
Procurement cost	$2,111.5	$10,848.3	413.8
Total program cost	$2,637.1	$11,918.7	352.0
Program unit cost	$25.115	$29.871	18.9
Total quantities	105	399	280.0
Acquisition cycle time (months)	79	94	19.0

The block 1 Reaper is in production, but the block 5 production decision was delayed 2 years to July 2013 to allow time for the program to fully integrate and test upgrades, such as system power increases, modernized crew stations, and improvements to the primary data link. Although the Reaper's critical technologies are mature and all design drawings have been released, the block 5 is still at risk for design changes until its upgrades are integrated and tested. According to program officials, operational testing for block 5 was also delayed 1 year to November 2013. This testing will include an evaluation of the block 1's hunter and net-ready capabilities, which were not included in its initial operational testing in 2008. The user is reevaluating its requirements and strategy for managing future Reaper upgrades; the increment II program was to begin in fiscal year 2012.

Attainment of Product Knowledge

As of January 2012

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

Reaper Program

Technology Maturity

The Reaper's block 1 and block 5 critical technologies are considered mature. An Air Force technology readiness assessment conducted in 2010 identified two critical technologies for the block 5 configuration—a high-capacity starter/generator and modified engine—and assessed them as mature. In addition to these critical technologies, there are other key enhancements for block 5 that are expected to improve the capability of the system, including upgrades to the radar, data link, sensor, landing gear, and ground control stations. These upgrades must still be successfully integrated and tested on the MQ-9 system. The production decision for the block 5 has been delayed by 2 years to July 2013 because of concerns about software delays and the amount of developmental and integration testing remaining.

Design Maturity

According to the program office, the Reaper design is stable and all the expected design drawings have been released; however, the block 5 is still at risk for design changes until its upgrades are integrated and tested on the MQ-9 system. The transition from block 1 to block 5 increased the number of design drawings by about 20 percent, which program officials attribute primarily to the relocation of radio antennas to the wingtips and a redesign of the avionics bay. The program office conducted a critical design review for block 5 in January 2011. Program officials expect to close all the action items, the most significant of which involves testing the aircraft's airworthiness with the relocated antennas, by early 2012.

Production Maturity

The block 1 Reaper is in production and the production processes for block 5 are approaching the level of maturity recommended for low-rate initial production. The Air Force has contracted for 117 block 1 aircraft, about 30 percent of its total requirement, and has conducted several manufacturing reviews of the contractor's facilities and determined that the production capacity is sufficient to meet the expected demand.

Other Program Issues

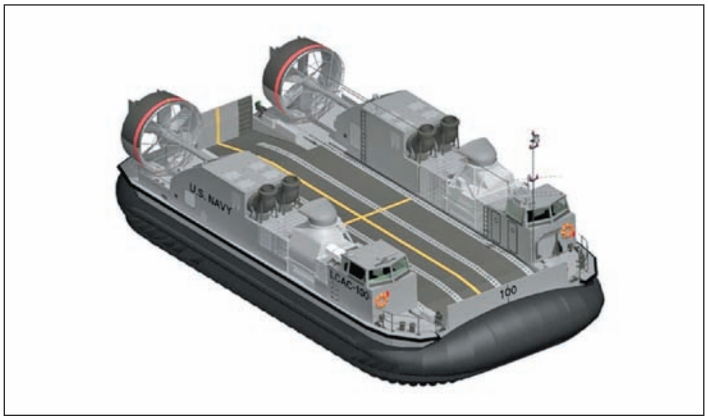
Since inception, the MQ-9 program has been challenged to meet the warfighter's changing needs. Quantities have increased dramatically and performance requirements continue to change. The program is currently incorporating several urgent operational requirements from the warfighter and officials expect other capabilities, such as the advanced signals intelligence payload sensor, to be added to the program. Although block 1 initial operational testing was done in 2008, problems with the radar and network prevented testers from evaluating the system's hunter and net-ready capabilities—two of its three key requirements. Testing of these capabilities was deferred until block 5 operational testing, which is currently planned for November 2013, a 1-year delay. The program also received approval to reduce or defer 12 required block 5 capabilities related to aircraft endurance, radar performance, and reliability, among other areas. According to the program office, none of these changes present a high operational risk for the system and some of them may be addressed in future upgrade efforts. According to program officials, the user is currently reevaluating its requirements and strategy for managing future Reaper upgrades. The increment II program, which included Small Diameter Bomb integration, automatic take-off and landing, deicing, and national airspace certification, was to begin in fiscal year 2012. According to program officials, the user is evaluating the feasibility of satisfying these requirements by upgrading the current configuration.

Program Office Comments

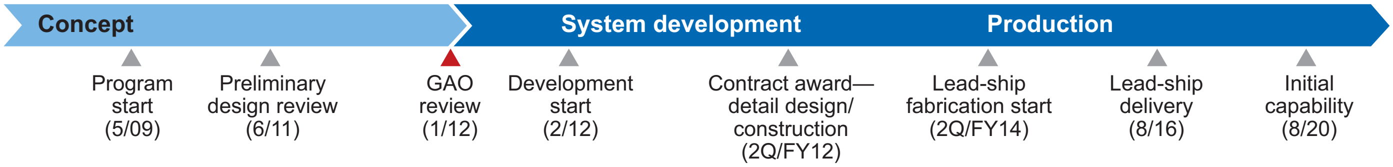
In commenting on a draft of this assessment, the Air Force stated that the program office is working to accelerate the low-rate initial production decision from July 2013 to June 2012. In order to accomplish this, the contractor has accelerated the first block 5 aircraft retrofit by 6 months and is focusing on developing software for the block 5 to allow for earlier verification. This accelerated date is also based upon tailoring of acquisition documents and schedule assumptions identified in the draft acquisition strategy that will require approval from the Office of the Secretary of Defense. The Air Force further stated that the increment II program is currently unfunded. The Air Force is reevaluating requirements and its strategy for future program upgrades.

Ship to Shore Connector (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 (LCAC), which is approaching the end of its service life. The SSC will deploy in Navy well deck amphibious ships, such as the LPD 17 class, and will be used for assault and nonassault operations. It is expected to operate independent of tides, water depth, underwater obstacles, ice, mud, or beach conditions.



Source: U.S. Navy.



Program Essentials

Prime contractor: TBD
Program office: Washington, DC
Funding needed to complete:
  R&D: TBD
  Procurement: TBD
  Total funding: TBD
  Procurement quantity: 72

Program Performance (fiscal year 2012 dollars in millions)

	As of	Latest 08/2011	Percent change
Research and development cost	NA	$442.7	NA
Procurement cost	NA	$3,947.6	NA
Total program cost	NA	$4,412.9	NA
Program unit cost	NA	$60.451	NA
Total quantities	NA	73	NA
Acquisition cycle time (months)	NA	135	NA

The SSC program has attained the level of knowledge about technology and design requirements needed to support the award of a detail design and construction contract for the lead craft, which is planned for the second quarter of fiscal year 2012. A 2010 technology readiness assessment found the program's one critical technology to be mature, and designated two technologies as watch items until a contractor selects the actual technologies to be used. According to the program office, the SSC is the first Navy-led ship design in 15 years and the Navy plans to provide two-dimensional extracted drawings from the design model to the contractor, who will then complete the design to prepare for production. The SSC is also being designed for affordability and the Navy has identified several performance tradeoffs to lower costs.

Attainment of Product Knowledge

Projected as of January 2012

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

SSC Program

Technology Maturity

The SSC program expects to award a detail design and construction contract in the second quarter of fiscal year 2012 with its one critical technology—the fire suppression system—mature. A 2010 technology readiness assessment by the Navy found this technology to be mature because the system had been extensively tested in an LCAC engine module modified to have similar characteristics to the SSC. In addition, the canisters that are part of the fire suppression system are commercially used and will not be modified for use on the SSC. Based on the technology readiness assessment, the Navy also decided that several other technologies should not be considered critical. For example, program officials stated the assessment did not identify the composite shaft as a critical technology because the composite material is already used on a Littoral Combat Ship. Other items, such as the gas turbine and the command, control, communications, computer, and navigation system were not designated critical because mature systems that meet all SSC requirements are available. However, these two technologies will remain on a watch list until the contractor selects the actual technologies to be used. According to program officials, there is a reasonable chance that the contractor could propose new technologies that require additional development if they have the potential to reduce cost.

Design Maturity

The Navy plans to stabilize the SSC design before the start of construction. According to program officials, after award of the detail design and construction contract, the Navy will provide two-dimensional extracted drawings from the design model to the contractor who will then complete the design of the craft for production. The Navy's request for proposal for detail design and construction requires the contractor to hold a production readiness review before the start of construction to demonstrate design maturity. Specifically, the contractor must demonstrate that both the functional design is 100 percent complete and the detailed production work packages are at least 95 percent complete before production start.

Other Program Issues

According to the program office, the SSC is the first Navy-led ship design in 15 years. The goal of the Navy-led design was to improve the capacity and maintainability of the SSC compared to the legacy LCAC, while reducing costs. To assist with this goal, the Navy conducted an analysis of the LCAC which focused on reducing total ownership cost while maintaining certain essential capabilities such as speed. Through this analysis, the Navy identified several performance trades. For example, the Navy identified a change to the cargo deck width which will allow for the use of nondevelopmental engines; this change is expected to lower life-cycle costs. The SSC is also expected to have greater lift, a lower fuel consumption rate, and less expected maintenance than the LCAC.

The Navy is conducting a full and open competition for the SSC detail design and construction contract. The Navy plans to award a fixed-price incentive contract for the detail design and construction of the lead craft, which is expected to be delivered by August 2016. The lead craft will be for testing and training and the contract is expected to have options for eight additional SSCs.

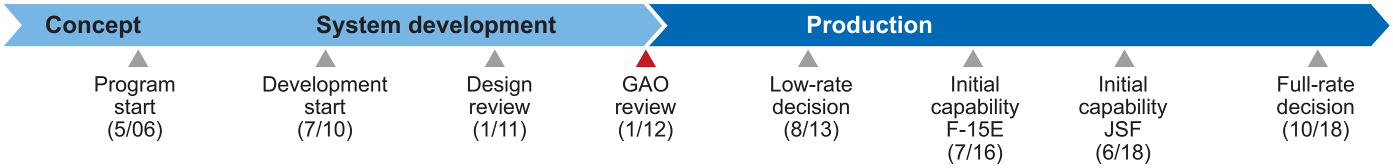
Program Office Comments

In commenting on a draft of this assessment, the Navy stated that the SSC is a technically mature, low risk program poised for successful entry into system development, program initiation, and detail design and lead craft construction contract award. The Navy also provided technical comments, which were incorporated as appropriate.

Small Diameter Bomb (SDB) Increment II

The Air Force's Small Diameter Bomb (SDB) Increment II is planned to provide attack capability against mobile targets in adverse weather from standoff range. It combines radar, infrared, and semiactive laser sensors in a multi-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 F-15E, Navy and Marine Corps' Joint Strike Fighter (JSF), and other aircraft, such as the F-22A.

Source: © 2009 Raytheon Company.



Program Essentials

Prime contractor: Raytheon
Program office: Eglin AFB, FL
Funding needed to complete:
  R&D: $850.1 million
  Procurement: $3,053.1 million
  Total funding: $3,903.2 million
  Procurement quantity: 17,000

Program Performance (fiscal year 2012 dollars in millions)

	As of 10/2010	Latest 08/2011	Percent change
Research and development cost	$1,644.8	$1,642.5	-0.1
Procurement cost	$3,057.3	$3,053.1	-0.1
Total program cost	$4,702.1	$4,695.6	-0.1
Program unit cost	$.274	$.274	-0.1
Total quantities	17,163	17,163	0.0
Acquisition cycle time (months)	72	72	0.0

The SDB II program completed its critical design review in January 2011 with a stable design, but without fully maturing its critical technologies or demonstrating that the design can perform as expected. As a result, the risk of design changes remains. A postdesign review identified several risks related to weapon effectiveness verification, target classification, seeker reliability, and JSF integration. The program office is working to address each of these risks and plans to begin evaluating the reliability and performance of the weapon through flight testing in March 2012. However, the program's biggest risk—integration with the JSF—will not be resolved until after production begins. The program faces a shortfall in funding, and program officials are considering modifying the fixed-price incentive contract or the current scope of work to align with the funding profile.

Attainment of Product Knowledge

As of January 2012

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

The SDB II program entered system development in July 2010 with all four of its critical technologies—the target classifier, multimode seeker, net-ready data link, and payload (warhead/fuze)—nearing maturity. Although the program has completed its critical design review, it is just beginning to further demonstrate these technologies through subsystem testing. According to the program office, subsystem testing is progressing well. Prototype testing is scheduled to begin in February 2012 and will demonstrate the weapon's ability to interface with the required aircraft and the seeker's performance.

Design Maturity

The SDB II design is currently stable, but it has not been demonstrated using a prototype to show that it will perform as expected. The risk of design changes will remain until the design shows it can meet requirements and other risks are addressed. The program completed its critical design review in January 2011 with 97 percent of its design drawings releasable. A postdesign review identified several risks related to weapon effectiveness verification, target classification, seeker reliability, and integration with the JSF. The program office is working to address each of these risks. In addition, the SDB II is scheduled to begin flight testing on the F-15E in March 2012; according to the program office, these tests will help to increase its confidence in the reliability and performance of the weapon. The SDB II program plans to conduct 11 free-flight test events prior to obtaining approval to begin production, which is currently scheduled to occur in August 2013.

According to the postdesign review and program officials, the top risk for the SDB II program is integration of the weapon with the JSF. The SDB II, which is carried in the JSF's internal weapons bay, was designed to operate in the environment specified in JSF design documents. However, the weapons bay environment has not been validated through testing. If the JSF cannot meet its design specifications, then the SDB II program may not meet its requirements for weapon effectiveness or availability on that aircraft; it might also have to consider design changes. This issue will not be resolved prior to the SDB II's planned August 2013 production decision and could affect the program's full-rate production in 2018. SDB II integration on the JSF is planned to begin in fiscal year 2015 and operational testing is planned for 2017.

Production Maturity

The SDB II program plans to take several steps to demonstrate the maturity of its manufacturing processes prior to beginning production. The program will demonstrate its critical manufacturing processes on a pilot production line and demonstrate that the system will work as intended in a reliable manner by testing a fully configured production-representative prototype.

Other Program Issues

The SDB II program office is managing a $53 million funding shortfall in fiscal year 2011, which could have programmatic and contractual implications. The SDB II contract is an incrementally funded, fixed-price incentive contract, and program officials stated that the funding shortfall could mean that the next part of the work will have to be deferred or the contract will need to be renegotiated or terminated.

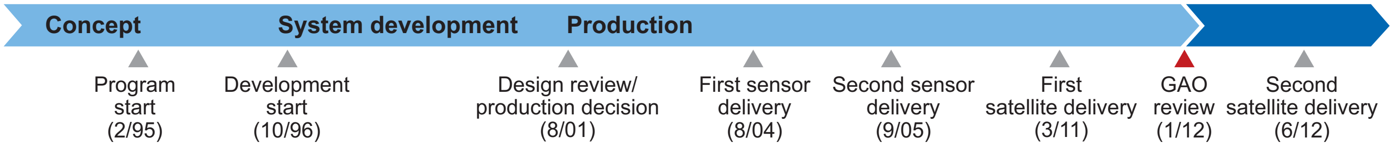
Program Office Comments

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

Space Based Infrared System (SBIRS) High Program

The Air Force's SBIRS High satellite system is being developed to replace the Defense Support Program and perform a range of missile warning, missile defense, technical intelligence, and battlespace awareness missions. SBIRS High will consist of four satellites in geosynchronous earth orbit (GEO), two sensors on host satellites in highly elliptical orbit (HEO), two replenishment satellites and sensors, and fixed and mobile ground stations. We assessed the space segment and made observations about the ground segment.

Source: © 2007 Lockheed Martin Corporation.



Program Essentials

Prime contractor: Lockheed Martin
Program office: El Segundo, CA
Funding needed to complete:
  R&D: $2,131.3 million
  Procurement: $3,599.4 million
  Total funding: $5,743.9 million
  Procurement quantity: 2

Program Performance (fiscal year 2012 dollars in millions)

	As of 10/1996	Latest 07/2011	Percent change
Research and development cost	$4,376.3	$11,586.3	164.7
Procurement cost	$0.0	$6,429.3	NA
Total program cost	$4,596.5	$18,266.7	297.4
Program unit cost	$919.301	$3,044.443	231.2
Total quantities	5	6	20.0
Acquisition cycle time (months)	86	TBD	NA

The 1996 data show no procurement cost as the Air Force planned to use research and development funds to buy all five satellites. The cost of the two HEO replenishment sensors is not included in either column.

The first SBIRS satellite was launched in May 2011—roughly 9 years later than planned—however, it lacks some key capabilities. The satellite was launched without a fully developed ground system or the flight software needed to automatically recover if an unforeseen failure occurs. According to program officials, the ground system will not be able to meet all of its operational requirements until at least 2018. The satellite recovery software will be uploaded to the satellite on-orbit once it is complete, expected in August 2012. The first satellite has begun on-orbit testing, but its planned operational certification in late 2012 will likely be delayed to early 2013. The program expects the cost of the third and fourth satellites to grow significantly. A new program baseline, which includes revised cost estimates and satellite and ground system delivery milestones, awaits DOD approval.

Attainment of Product Knowledge

As of January 2012

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

SBIRS High Program

Technology, Design, and Production Maturity

According to the SBIRS program office, the system's critical technologies are mature, its design is stable, and its manufacturing processes have been proven; however, the program continues to experience quality problems that have required rework on the first two satellites. Functional testing on the first satellite in 2009 revealed solder fractures on some hardware components and testing on the second satellite in 2011 has uncovered anomalies and erratic performance on similar components. In both cases, some rework has been required to the satellites; however, program officials do not expect that these issues will result in significant cost growth or schedule delays. System-level testing on the second satellite has begun and the program expects it to be delivered in June 2012. Its launch date has yet to be determined.

The SBIRS program plans to make slight changes to the design of its two HEO replenishment sensors, addressing parts obsolescence and electromagnetic interference issues that affected the operation of its first two sensors. Replenishment sensors are scheduled for delivery and integration onto host satellites in fiscal years 2012 and 2015.

Other Program Issues

The first GEO satellite, and likely second, will be launched and operating on-orbit before the program can fully leverage the satellites' capabilities. The SBIRS program opted to launch the first GEO satellite in May 2011 before the ground system, which processes data from the satellite's infrared sensors, was fully developed. According to the program office, it did so to provide some capability to users sooner. Ground system development has proved more difficult than anticipated and officials say the system will not be able to fully meet its operational requirements until at least 2018. In the meantime, ground system capabilities will be fielded incrementally. According to the Defense Contract Management Agency, the flight software development effort is still experiencing challenges and delays. The first satellite was launched without all of the planned flight software functionality, including, for example, a capability that allows the satellite to automatically recover without ground intervention from a "fault-mode" in the event of an unforeseen failure. The program intends to upload this software to the first satellite on-orbit after it completes development. According to the Defense Contract Management Agency, on-orbit check out activities, for example, system-level testing and calibration, are currently 6 weeks behind schedule, which could delay the operational certification of the first satellite, planned for late 2012.

According to the SBIRS program, production of the third and fourth satellites may experience significant cost growth and schedule delays due to development challenges, test failures, and technical issues. The Air Force is projecting a cost overrun of $438 million and 1-year delay for these two satellites. The program plans to award a sole-source contract to the same prime contractor to build the fifth and sixth satellites. The SBIRS program has revised its acquisition program baseline, which will include revised cost estimates and new satellite and ground system delivery milestones, but DOD has yet to approve it.

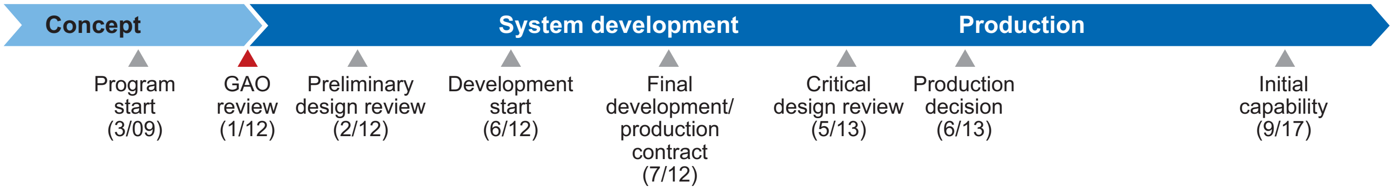
Program Office Comments

In commenting on a draft of this assessment, the program office stated that the first satellite launched with all the software needed to support vehicle health and safety. Sensors on the first satellite are collecting higher-quality data than expected. The satellite is moving to its operational location, and officials expect trial operations to last from November 2012 to January 2013. The follow-on production contract is delivering flight hardware, but is experiencing cost and schedule pressure due to parts obsolescence and technical issues. Officials attribute this to an 8-year production gap between the first two satellites and the third and fourth. The revised acquisition program baseline is final as of January 2012. The acquisition strategy for the fifth and sixth satellites is pending, and the program is seeking approval to release requests for proposals and contract awards. The program office also provided technical comments, which were incorporated as appropriate.

Space Fence

The Air Force's Space Fence will be a new system of large ground-based radars that replaces the Air Force's aging Space Surveillance System. It will use higher radio frequencies to detect and track smaller Earth-orbiting objects. The system will consist of two geographically dispersed radars to help ensure effective space surveillance coverage for low inclinations. The system's enhanced capabilities are expected to significantly increase the number of orbiting objects detected and tracked.

Source: U.S. Air Force.



Program Essentials

Prime contractor: Lockheed Martin, Raytheon
Program office: Hanscom AFB, MA
Funding needed to complete:
  R&D: TBD
  Procurement: TBD
  Total funding: TBD
  Procurement quantity: 1

Program Performance (fiscal year 2012 dollars in millions)

	As of	Latest 08/2011	Percent change
Research and development cost	NA	TBD	NA
Procurement cost	NA	TBD	NA
Total program cost	NA	TBD	NA
Program unit cost	NA	TBD	NA
Total quantities	NA	2	NA
Acquisition cycle time (months)	NA	103	NA

In May 2010, the program office estimated the Space Fence's total cost would be over $3 billion; an updated estimate has not been provided.

The Space Fence program office expects to have gained key knowledge about its technology and requirements before it enters system development in June 2012. Its four critical technologies are nearing maturity and it will hold a preliminary design review prior to development start. The current technology development phase involves multiple contractors and competitive prototyping demonstrations. The program plans to award a single contract for system development and production in July 2012. The first Space Fence radar site is scheduled to provide an initial operational capability by the end of fiscal year 2017—2 years later than originally planned—and the Air Force will be required to support the existing surveillance system longer than anticipated. A new data-processing system is also being developed by a separate program to accommodate the increased volume of data from Space Fence.

Attainment of Product Knowledge

Projected as of January 2012

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 Program

Technology Maturity

The Space Fence program expects its four critical technologies to be nearing maturity before it enters system development in June 2012. The technologies include a software algorithm for estimating orbits and several radar technologies—a high-efficiency power amplifier; low-cost distributed receiver; and scalable digital beam former that allows antennas to work in concert to create sufficient power to conduct the space surveillance and tracking mission. Mature backup technologies that have potentially higher acquisition or operating costs also exist, but program officials do not believe they will be needed. According to the program, the Space Fence will be one of the largest phased array radars ever built, and the key risks are related to its size and the integration of technology components into a viable system at an affordable cost. According to the program office, its technology development efforts, which involve multiple contractors, will allow the program to thoroughly examine the contractors' designs and their associated costs, while reducing technical risk and improving confidence in the producibility of the key technologies and components.

Other Program Issues

The Space Fence program maintained competition through technology development and plans to competitively award a single contract for system development and production. In June 2009, the Air Force competitively awarded three $30 million firm fixed-price contracts to begin technology development, one of which was subsequently terminated after a reduction in program funding. After a full and open competition, the two other contractors were each awarded another contract in January 2011, for a maximum of $214 million, to continue technology development. The Space Fence program plans to conduct a full and open competition and award a single contract for system development and production in July 2012. According to the program office, the release of the request for proposal for this contract has been delayed from December 2011 to April 2012 because DOD now requires a program review to be held before its release. However, the program office believes the contract can still be awarded on schedule. The program office plans to award a firm fixed-price contract for system development activities through the planned May 2013 critical design review, with options for all subsequent efforts, including radar production.

The first Space Fence radar site is scheduled to provide initial operational capability by the end of fiscal year 2017—2 years later than planned—because current program funding levels do not support an earlier date. As a result, the Air Force will be required to support the existing surveillance system longer than anticipated. It is currently assessing ways to keep the system in operation until the Space Fence is ready. The second Space Fence site will provide a full operational capability by 2020.

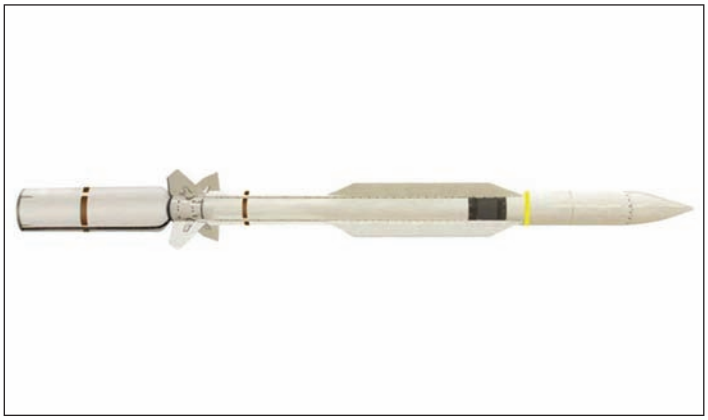
A new data-processing capability is being developed by a separate program to accommodate the increased volume of data from Space Fence. According to the Space Fence program office, this program is currently being restructured and should be fielded in time to support Space Fence.

Program Office Comments

In commenting on this draft, the program office noted that it generally concurred with our assessment. The program noted that a technology readiness assessment is ongoing and the Space Fence preliminary design review is on schedule to be completed by the end of February 2012. The program also provided technical comments, which were incorporated as appropriate.

Standard Missile-6 (SM-6) Extended Range Active Missile (ERAM)

The Navy’s Standard Missile-6 (SM-6) is a surface-to-air missile launched from Aegis ships. It is designed to provide ship self-defense, fleet defense, and theater air defense against aircraft, ships, and missiles at various altitudes over land and sea. It will provide an over-the-horizon engagement capability and improved capabilities at extended ranges by combining legacy Standard Missile and Advanced Medium-Range Air-to-Air Missile (AMRAAM) technology. We assessed SM-6 block 1. Follow-on blocks will be developed to meet future threats.



Source: Raytheon Missile Systems.

Program Essentials

Prime contractor: Raytheon Missile Systems
Program office: Arlington, VA
Funding needed to complete:
  R&D: $7.6 million
  Procurement: $4,808.9 million
  Total funding: $4,816.6 million
  Procurement quantity: 1,111

Program Performance (fiscal year 2012 dollars in millions)

	As of 07/2004	Latest 12/2010	Percent change
Research and development cost	$1,073.8	$973.5	-9.3
Procurement cost	$4,626.4	$5,323.2	15.1
Total program cost	$5,700.2	$6,296.7	10.5
Program unit cost	$4.750	$5.247	10.5
Total quantities	1,200	1,200	0.0
Acquisition cycle time (months)	75	94	25.3

The SM-6’s highly concurrent testing and production strategy puts the program at increased risk of cost growth and schedule delays. The program has 89 missiles under contract, but it has not yet demonstrated that its manufacturing processes are in control or the missile is reliable, suitable, and effective in its operational environment. The program has experienced numerous developmental and operational test failures. Program officials stated that root causes have been identified and corrective actions will be addressed during follow-on testing. The program plans to request approval to enter full-rate production in May 2012; and the Under Secretary of Defense for Acquisition, Technology and Logistics will have to determine whether additional flight testing is needed, or if the current risks on the program will continue to be carried forward into full-rate production.

Attainment of Product Knowledge

As of January 2012

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

SM-6 Program

Technology and Design Maturity

According to the program office, all SM-6 critical technologies are mature and its design is stable; however, the program is still at risk of late design changes because of repeated test failures. The program obtained approval to conduct limited developmental testing because the risk of integrating the legacy AMRAAM missile seeker with the Standard Missile was perceived to be low. However, over half of the SM-6's at-sea developmental flight tests experienced anomalies or resulted in failure with multiple issues attributed to these legacy components. A May 2011 operational test readiness assessment concluded that the program faced a high risk of failure in operational testing and recommended additional developmental testing. The program proceeded with operational testing in June 2011 and the missile failed 5 of 12 tests. According to program officials, all failures have had root causes discovered, and corrective actions will be verified during follow-on operational testing, which is scheduled to occur after the program's planned May 2012 full-rate production decision. The Navy's operational test organization plans to issue its assessment of operational testing by April 2012 to support the full-rate production review.

Production Maturity

The SM-6 program has proven out its production processes, but has not yet demonstrated that its critical processes are in control or that the missiles being produced perform reliably. According to the program, the sample size needed for measuring process control will not be achieved until 2014.

Other Program Issues

The SM-6's highly concurrent testing and production strategy puts the program at increased risk of cost growth and schedule delays. The program has made a significant investment before demonstrating that the design meets performance requirements and that the missile is reliable, suitable, and effective in its operational environment. In 2009, the program obtained approval from the Under Secretary of Defense for Acquisition, Technology and Logistics to begin low-rate production of up to 19 missiles before completing developmental testing. To minimize risks, the Under Secretary required the program to complete developmental testing and obtain approval prior to awarding additional contracts. The Under Secretary subsequently approved the award of two additional low-rate production contracts before this testing was complete. After numerous developmental test failures, the program carried a significant level of risk into operational testing where the high failure rate continued. The program plans to seek approval for full-rate production in May 2012 and to award a full-rate production contract with options through fiscal year 2016. The Under Secretary will have to determine whether additional flight testing is needed, or if the risks on the program will continue to be carried forward into full-rate production. Further, multiple SM-6 capabilities will not be tested until full-rate production is well underway. According to officials, the program plans to have 387 of 1,200 missiles under contract by the end of fiscal year 2014. This is before the SM-6 will be tested with the Naval Integrated Fire Control–Counter Air System, which enables its over-the-horizon capabilities.

Program Office Comments

In commenting on a draft of this assessment, the Navy disagreed with our assertions that the program is at risk of design changes because of repeated test failures; that the program has not demonstrated that its critical processes are in control and that the missile meets performance requirements; and that multiple capabilities will not be tested until full-rate production is well underway. According to program officials, the missile design is mature and stable, and all flight failures and anomalies are understood with corrective actions in place or in progress. The program office also provided technical comments, which were incorporated as appropriate.

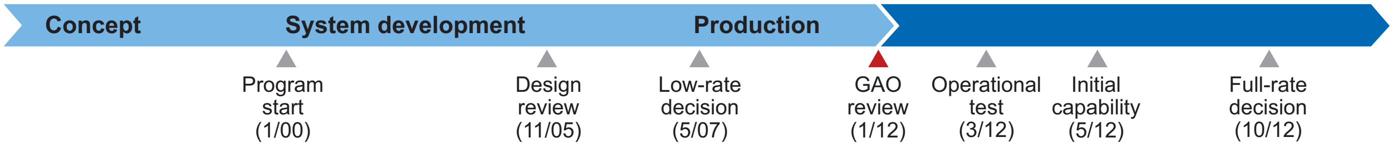
GAO Response

According to program officials, the SM-6 design is stable; however, the program has not yet demonstrated that the system is reliable, suitable, and effective in its operational environment. Our reviews of DOD weapon systems confirm that production costs are minimized when a fully integrated, capable prototype is demonstrated to show that the system will work as intended in a reliable manner.

Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle (VTUAV)

The Navy's VTUAV is intended to provide real-time imagery and data in support of intelligence, surveillance, and reconnaissance missions. A VTUAV system is composed of up to three air vehicles with associated sensors, two ground control stations, one recovery system, and spares and support equipment. The air vehicle is launched and recovered vertically, and operates from ships and land. The VTUAV is being designed as a modular, reconfigurable system that supports various operations, including surface, antisubmarine, and mine warfare.

Source: Northrop Grumman.



Program Essentials

Prime contractor: Northrop Grumman
Program office: Patuxent River, MD
Funding needed to complete:
  R&D: $16.2 million
  Procurement: $1,582.8 million
  Total funding: $1,599.0 million
  Procurement quantity: 145

Program Performance (fiscal year 2012 dollars in millions)

	As of 12/2006	Latest 09/2011	Percent change
Research and development cost	$598.0	$682.1	14.1
Procurement cost	$1,682.6	$1,933.2	14.9
Total program cost	$2,615.4	$2,615.4	0.0
Program unit cost	$14.776	$14.945	1.1
Total quantities	177	175	-1.1
Acquisition cycle time (months)	104	148	42.3

The VTUAV program continues to experience delays as a result of issues identified during testing. According to the program, it has made hardware and software changes to address the issues and improve the reliability, maintainability, and availability of the air vehicle and ground control station. The program has delayed the planned start of operational testing to March 2012 and could have difficulty demonstrating certain aspects of the system's effectiveness and suitability. DOD's independent test organization and military commanders have stated that the system provides a valuable capability, but the test organization has expressed concerns about data link reliability and launch delays. The program is planning several aircraft upgrades, including a multimode maritime radar, forward-firing weapon, and larger airframe to improve endurance, payload, and carrying capacity.

Attainment of Product Knowledge

As of January 2012

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

VTUAV Program

Technology Maturity

The VTUAV program did not identify any critical technologies. According to the program office, it relies on common, mature technologies.

Design Maturity

The VTUAV design appears stable and the program has released all its expected drawings; however, the program has made a number of software and hardware changes to correct issues identified in developmental testing. According to the program, the main issues in testing were related to the reliability, maintainability, and availability of the air vehicle and the control station. Several critical components experienced unanticipated failures, but were corrected with software or hardware improvements. As a result of the problems highlighted during developmental testing, the VTUAV program delayed the planned start of operational test and evaluation until March 2012. The program plans to reach initial operational capability in May 2012 and enter full-rate production in October 2012—more than 2 years later than planned.

Production Maturity

The VTUAV program's production processes have been demonstrated, but we could not assess whether its critical processes are in control. The program does not collect data on statistical process controls or assess process capabilities using manufacturing readiness levels. As of fiscal year 2011, the program planned to convert eight Army aircraft bought under the Future Combat Systems into Navy VTUAV aircraft.

Other Program Issues

The VTUAV program may have difficulty demonstrating its effectiveness and suitability in operational testing. An early fielding report by the Director, Operational Test and Evaluation, concluded that the VTUAV can be a valuable intelligence-gathering asset, but forces should not depend on it to provide time-sensitive support to ground forces because of the fragile nature of the data link and frequent launch delays. According to the report, a primary reason for these delays is multiple ground control station configurations, which makes it difficult for the program to identify and correct the root causes of problems and replicate failure modes to assist the operator in troubleshooting issues. According to the program office, the VTUAV's deployments aboard the USS *Halyburton* and in Afghanistan have demonstrated the military utility of the system, and the operational commands in Afghanistan have requested doubling the VTUAV capability there. The Navy recently lost a VTUAV aircraft in Libya due to enemy actions.

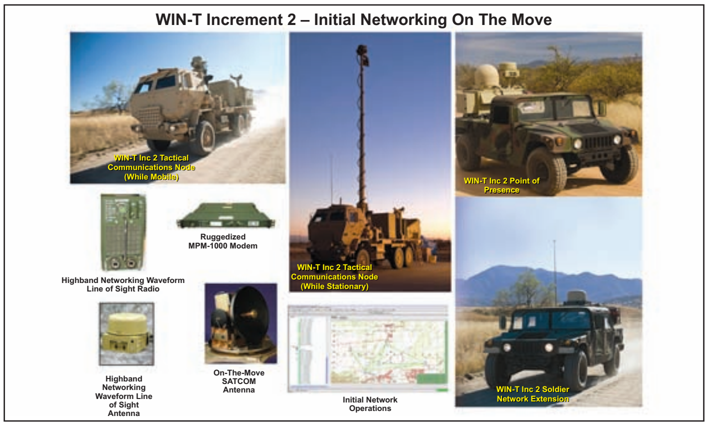
The VTUAV program is planning several upgrades of the system. For example, the program is planning to acquire a multimode maritime radar and forward-firing weapon for installation on the aircraft using a rapid acquisition process that enables the capabilities to be delivered to the warfighter quickly. Both capabilities will be acquired as a part of the current program and will undergo a formal quick-reaction assessment in fiscal year 2013 prior to their planned deployment. In addition, the program plans to buy 28 upgraded aircraft with a larger airframe to improve endurance, payload, and future carrying capacity.

Program Office Comments

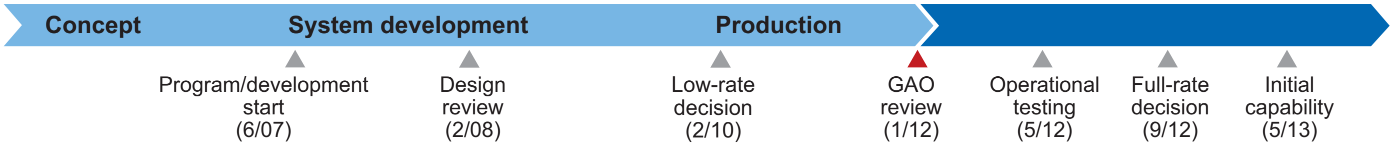
The program office concurred with this assessment.

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

WIN-T is the Army's high-speed and high-capacity backbone communications network. WIN-T connects Army units with higher levels of command and provides the Army's tactical portion of the Global Information Grid. WIN-T was restructured following a March 2007 Nunn-McCurdy unit-cost breach of the critical threshold, and will be fielded in four increments. The second increment will provide the Army with an initial networking on-the-move capability.



Source: U.S. Army.



Program Essentials

Prime contractor: General Dynamics C4 Systems, Inc.
Program office: Aberdeen Proving Ground, MD
Funding needed to complete:
- R&D: $29.3 million
- Procurement: $4,803.2 million
- Total funding: $4,832.5 million
- Procurement quantity: 2,390

Program Performance (fiscal year 2012 dollars in millions)

	As of 10/2007	Latest 12/2010	Percent change
Research and development cost	$238.6	$279.2	17.0
Procurement cost	$3,469.8	$5,773.5	66.4
Total program cost	$3,708.4	$6,052.7	63.2
Program unit cost	$1.959	$2.127	8.6
Total quantities	1,893	2,846	50.3
Acquisition cycle time (months)	50	71	42.0

The WIN-T Increment 2 entered production in February 2010 with mature critical technologies, a stable design, and production processes that had been demonstrated, but were not in control. The program's assessment of its manufacturing readiness level indicates that it has not yet demonstrated the capability recommended by DOD guidance to begin full-rate production, which is currently planned for September 2012. The program has been working to address performance and reliability shortfalls revealed in a March 2009 limited user test. According to the program office, production qualification testing has been successful, and the program believes it will demonstrate the required performance and reliability during initial operational testing, which is scheduled to begin in May 2012.

Attainment of Product Knowledge

As of January 2012

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 2 Program

Technology Maturity

All 15 WIN-T Increment 2 critical technologies were mature by its February 2010 production decision. In November 2009, the Director, Defense Research and Engineering, concurred with an independent review team's assessment of the program, noting that tests conducted by the Army show that each of WIN-T Increment 2's critical technologies have been demonstrated in a realistic environment.

Design Maturity

According to the WIN-T program, it has integrated and tested its key technologies and subsystems, which demonstrates that the system's design is capable of working as intended. The program office does not track the other metric we use to measure design maturity—the number of releasable drawings—because 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 test events designed to demonstrate performance at increasing levels of system integration, and design stability is measured through problem-tracking report trends.

Production Maturity

The WIN-T program began production in February 2010 with manufacturing processes that had been demonstrated on a pilot production line, but were not in control. The program's assessment of its manufacturing readiness level does not indicate that its production processes are in statistical control or that the program has demonstrated that the capability recommended by DOD guidance is in place to begin full-rate production, which is currently planned for September 2012. According to the WIN-T program, it uses commercially available products and does not have any critical manufacturing processes.

Other Program Issues

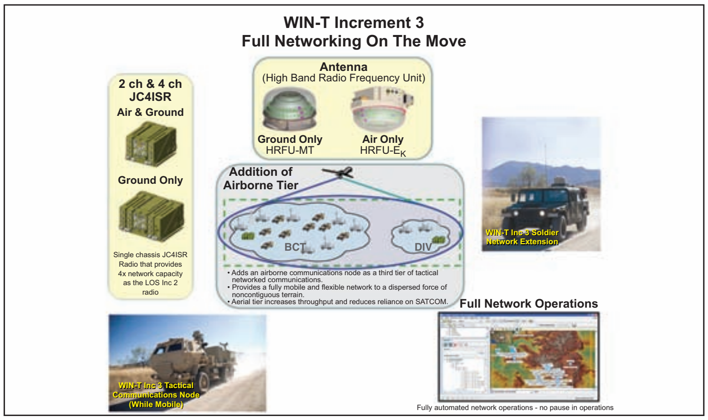
According to the WIN-T program, it has addressed the deficiencies identified in its March 2009 limited user test and is prepared to begin initial operational testing on schedule in May 2012. During the limited user test, WIN-T Increment 2 failed to demonstrate the ability to support mobile operations as well as the required capabilities in forested terrain. WIN-T Increment 2 operational effectiveness was degraded because the program's concept of operations, organizational structure, and manning were not adequate to operate and troubleshoot the network. Further, the test concluded that the WIN-T Increment 2 did not meet its operational reliability requirements because three critical components demonstrated poor reliability. After this test, DOD's Director, Operational Test and Evaluation, recommended that the Army improve the performance of the Increment 2 waveforms, provide greater training to soldiers, refine its tactics and manning levels for Increment 2, and aggressively pursue a reliability growth program for WIN-T Increment 2 components to ensure its success in initial operational testing. According to the program office, production qualification testing conducted by the contractor in early 2011 indicated that the system is on target to meet its minimum performance requirements. Reliability issues were identified during that testing, but the program believes that each of the program's configuration items is meeting its reliability growth target, and that the program will demonstrate required performance and reliability during upcoming initial operational testing.

Program Office Comments

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

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

WIN-T is the Army's high-speed and high-capacity backbone communications network. WIN-T connects Army units with higher levels of command and provides the Army's tactical portion of the Global Information Grid. WIN-T was restructured following a March 2007 Nunn-McCurdy unit-cost breach of the critical threshold, and will be fielded in four increments. The third increment will provide the Army a full networking on-the-move capability.



Source: U.S. Army.

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

Program/development start (7/03)
GAO review (1/12)
Design review (8/14)
Low-rate decision (4/15)
Full-rate decision (9/18)
Initial capability (4/19)

Program Essentials

Prime contractor: General Dynamics C4 Systems, Inc.
Program office: Aberdeen Proving Ground, MD
Funding needed to complete:
R&D: $890.3 million
Procurement: $11,649.1 million
Total funding: $12,539.4 million
Procurement quantity: 3,168

Program Performance (fiscal year 2012 dollars in millions)

	As of 05/2009	Latest 12/2010	Percent change
Research and development cost	$2,687.4	$2,222.3	-17.3
Procurement cost	$13,680.3	$11,649.1	-14.8
Total program cost	$16,367.7	$13,871.4	-15.3
Program unit cost	$4.701	$4.325	-8.0
Total quantities	3,482	3,207	-7.9
Acquisition cycle time (months)	165	187	13.3

The WIN-T Increment 3 program will not demonstrate the maturity of all its critical technologies until its planned April 2015 production decision. Three of the program's 20 critical technologies are currently mature and 15 are nearing maturity. Of the two remaining technologies, one was rated as nearing maturity by an independent review team; but in 2009, the Director, Defense Research and Engineering, concluded that the technology's ambiguous requirements made it difficult to state whether it had been adequately demonstrated. The Army has since revisited its requirements. According to the Army, the other technology—a cryptographic device—will be demonstrated by its system-level design review. The WIN-T Increment 3 schedule is likely to be negatively affected by an almost 40 percent reduction in planned funding for fiscal year 2012.

Attainment of Product Knowledge

As of January 2012

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

The WIN-T Increment 3 program will not demonstrate the maturity of all of its critical technologies in a realistic environment until its planned April 2015 production decision. An April 2009 review of the Army's technology readiness assessment for WIN-T Increment 3 by the Director, Defense Research and Engineering (DDR&E), concluded that, of the program's 20 critical technologies, 3 were mature, 15 were nearing maturity, and 2—the Quality of Service Edge Device (QED) and High Assurance Internet Protocol Encryptor (HAIPE) version 3.X—could not be formally rated.

The Army has rated the QED as nearing maturity; however, DDR&E concluded that this technology had ambiguous requirements that made it difficult to state whether it had been adequately demonstrated. DDR&E noted that while the Army had demonstrated that the QED technology met requirements under most conditions, in one stressing scenario, it did not. DDR&E representatives have stated in the past that it is unlikely that any network can meet this requirement in all environments. Since the QED technology was shown to be robust and capable of meeting its requirement in most scenarios, DDR&E recommended that the Army clarify the user's requirements for this technology by its system-level design review, currently scheduled for August 2014. According to a program official, the Army's Training and Doctrine Command has revisited the user requirements; however, it will still wait to reassess the QED's maturity until the system-level design review. According to the Army, the QED technology has been demonstrated in recent WIN-T Increment 2 production qualification tests. It is anticipated that the technology used in WIN-T Increment 2 can be applied to WIN-T Increment 3 with little or no changes to the existing functionality.

HAIPE version 3.X was not available to be assessed at the time of DDR&E's review; however, a National Security Agency (NSA) official has since said it is mature. HAIPE is a device that encrypts and encapsulates Internet protocol packets so that they can be securely transported over a network of a different security classification. DDR&E has notified the Army that the maturity of the HAIPE version 3.X technology should be established to DDR&E's satisfaction before it is transitioned into WIN-T Increment 3. HAIPE 3.1 is currently being used in the WIN-T Increment 2 network. According to the Army, this version has introduced some network efficiencies, but the HAIPE version 4.1 will be needed to support the full set of network efficiencies required by WIN-T Increment 3. The maturity of these critical technologies will be demonstrated in a realistic environment by the April 2015 production decision. The Army will clarify the user's requirements for these technologies by its system-level design review, currently scheduled for October 2012.

Other Program Issues

The WIN-T Increment 3 schedule is likely to be negatively affected by reductions in its planned funding for fiscal year 2012. The joint explanatory statement accompanying the Department of Defense Appropriations Act, 2012, recommended $183 million for WIN-T Increment 3 research, development, test, and evaluation funding, a 40 percent reduction from the budget request of $298 million. The Army explained that as a result of this reduction, the program has modified the program strategy to reflect a two-phased approach. The initial aerial tier capability is planned for the low-rate production decision in fiscal year 2015 and the full aerial tier capability supporting full networking on-the-move is planned for the full-rate production decision in fiscal year 2018.

Program Office Comments

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

Advanced Extremely High Frequency (AEHF) Satellite

The Air Force's AEHF satellite system will replenish the existing Milstar system with higher-capacity, survivable, jam-resistant, worldwide, secure communication capabilities for strategic and tactical warfighters. The program includes six satellites and a mission control segment. Terminals used to transmit and receive communications are acquired separately by each military service. AEHF is an international program that includes Canada, the United Kingdom, and the Netherlands.

Source: © 2009 Lockheed Martin Corporation. All rights reserved.

Current Status

The first AEHF satellite was launched in August 2010 and was expected to reach its planned orbit in about 3 months, but a propulsion system anomaly delayed the satellite's arrival on orbit. The Air Force used other propulsion systems designed to control and reposition the satellite to raise it into its intended orbit, a process it estimated would take 10 to 12 months. However, the program office, in conjunction with the user community, decided to extend the satellite's ascent to save fuel for on-orbit operations and the satellite reached its planned orbit in late October 2011. The satellite will go through about a 100-day checkout and testing period before it becomes available for operations.

The launch of the second and third AEHF satellites was delayed after the problems with the first satellite were discovered, but they have now been cleared for flight. The program office and prime contractor determined the propulsion system anomaly on the first satellite was most likely caused by debris in the system's oxidizer fuel line introduced during the manufacturing process. The second and third satellites, which were already built, were tested to confirm there were no similar blockages. The estimated launch dates for these satellites are April 2012 and the fall of 2013 respectively. The fourth satellite is under contract and is scheduled to be available for launch in 2017. The Air Force plans on procuring the fifth and sixth satellites using a block-buy acquisition strategy intended to produce savings that would be reinvested in research and development for follow-on systems. The Air Force requested congressional approval for the block buy in its fiscal year 2012 budget request. The last two satellites are tentatively expected to be available for launch in 2018 and 2019. In 2009, DOD announced the cancellation of the Transformational Satellite Communications System—the planned follow-on to AEHF. In June 2011, DOD commissioned an internal study to address follow-on programs for AEHF and the Wideband Global SATCOM communications programs, which will lead to a subsequent analysis of alternatives.

Estimated Total Program Cost: $14,082.8 million
Research and development: $7,759.4 million
Procurement: $6,323.4 million
Quantity: 6

Next Major Program Event: Launch of second AEHF satellite, April 2012

Program Office Comments: In commenting on a draft of this assessment, the Air Force noted that satellite command and control was transitioned from Milstar to the AEHF mission control segment in June 2011. The Air Force also provided technical comments, which were incorporated as appropriate.

B-2 Defensive Management System (DMS) Modernization

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


Source: U.S. Air Force.

Current Status

The B-2 DMS program was approved to enter technology development in August 2011. On the basis of an analysis of alternatives, the Air Force elected to fully modernize the B-2 DMS using a single-step rather than an incremental acquisition approach to deliver the intended capability. Using a single-step acquisition strategy can increase risk on a program because it can add complexity to design and software efforts. The B-2 DMS program is also implementing a rapid acquisition initiative, which it believes can reduce its acquisition cycle from 10 to 7 years and lower its cost by over $500 million. The initiative includes: (1) conducting early software prototyping; (2) reducing the time required for flight testing by utilizing a flying test bed for risk reduction, improving test-range access, and expediting test data analysis; and (3) improving installation times by using antennas that conform to the B-2 design. The program's current funding plan and schedule do not reflect the anticipated benefits of the initiative. According to the B-2 program office, it expects DOD to assess the program's progress in achieving the initiative's objectives before the start of system development, and will adjust the program's cost and schedule targets accordingly.

The B-2 DMS program office has identified five critical technologies, three of which are mature or nearing maturity. The program expects the two other technologies—the low-observable antennas for the B-2 leading edges and associated receivers—to be nearing maturity by the start of system development. The program does not plan to develop prototypes of the full B-2 DMS, but instead plans to prototype the antenna subsystems, which it believes presents a key technical risk. The program also identified the stringent nuclear hardening requirements of the B-2 design as a technical risk.

Estimated Total Program Cost: $1,979.9 million
Research and development: $1,259.1 million
Procurement: $720.8 million
Quantity: 20

Next Major Program Event: System development start, fourth quarter fiscal year 2013

Program Office Comments: The program was provided a draft of this assessment and had no comments.

B-2 Extremely High Frequency SATCOM Capability, Increment 2

The Air Force's B-2 EHF SATCOM is a satellite communication system designed to upgrade the aircraft's ultra-high-frequency system to ensure secure communication. The system has three increments. Each one is expected to be a major defense acquisition program. Increment 2 is designed to provide connectivity by adding low-observable antennas and radomes to the aircraft. It is also intended to include separate, nonintegrated Family of Advanced Beyond Line-of-Sight Terminals (FAB-T) and related hardware integral to the EHF SATCOM capability.

Source: U.S. Air Force.

Current Status

The B-2 EHF Increment 2 program is in technology development, but some work on the program has stopped. The program began a component advanced development effort in March 2008 that includes systems engineering, requirements analysis, technology maturation, and preliminary design activities. In August 2011, program officials told us that work related to FAB-T was halted because that program was experiencing FAB-T delivery delays. In October 2011, work on the active electronically scanned array (AESA) antenna system also ceased because of funding uncertainties for fiscal year 2012. While work on the antenna system resumed in December 2011, this was the latest in a series of delays for the Increment 2 program. The program's schedule before work stopped showed system development beginning in April 2013—3 years later than first planned—and production starting after the U.S. Strategic Command's identified need date of 2017.

If and when the B-2 EHF Increment 2 program fully resumes, FAB-T will continue to pose a significant risk. Program officials told us that a terminal, like FAB-T, is significant to the Increment 2 program because it handles the aircraft's communication with EHF satellites, analogous to how a phone or cable modem handles communication with the internet. The Air Force and the Increment 2 program office are looking at ways to mitigate the risk. Program officials told us the Air Force began exploring a potential alternate source for FAB-T in 2011, and the Increment 2 program office was investigating a different approach to secure communication that would not involve the EHF frequency or FAB-T.

In addition to FAB-T, antenna technology maturation is a program risk. The AESA antenna system the program is developing has several critical technologies that are still immature. The program does have a plan to mature these technologies prior to beginning system development in April 2013, but it does not have a backup antenna technology option should AESA not mature as expected.

Estimated Total Program Cost: $2,367.6 million
Research and development: $1,641.2 million
Procurement: $726.4 million
Quantity: 20

Next Major Program Event: System development start, April 2013

Program Office Comments: In commenting on a draft of this assessment, the B-2 program office provided technical comments, which were incorporated as appropriate.

BMDS: Aegis BMD Standard Missile-3 Block IIB

MDA's Aegis Ballistic Missile Defense (BMD) system is a sea- and land-based system being developed to defend against missiles of all ranges. It includes a radar, command and control systems, and Standard Missile-3 (SM-3) missiles. We reviewed the SM-3 Block IIB, which is planned to provide U.S. homeland defense through early intercept capability against some long-range ballistic missiles and regional defense against intermediate-range ballistic missiles. The SM-3 Block IIB is planned to be fielded in the 2020 time frame as part of the European Phased Adaptive Approach.

Source: Missile Defense Agency.

Current Status

The SM-3 Block IIB program entered technology development in July 2011 and awarded three contracts to conduct trade studies, define missile configurations, and produce development plans. One contractor will be selected for system development in 2013. The SM-3 Block IIB program is developing advance seeker and other technologies that cut across the SM-3's variants through a technology risk-reduction program.

According to a tentative schedule, the SM-3 Block IIB program plans to enter system development prior to holding a preliminary design review, raising the possibility of cost and schedule growth. The program is conducting a series of reviews to receive engineering insight into each contractor's design. While these reviews will provide important knowledge, we have reported that before starting system development, programs should hold key engineering reviews, culminating in the preliminary design review, to ensure that the proposed design can meet defined, feasible requirements within cost, schedule, and other system constraints. Beyond the crosscutting technologies the program is developing, it is taking steps to develop technology maturation plans that will include demonstrating technologies in a relevant environment using a representative model or prototype before the SM-3 Block IIB enters system development. The three contractors' plans are expected to outline the level of investment required to demonstrate this degree of technology maturity by 2014. Program officials have not yet defined the specific critical technologies for the SM-3 Block IIB, which could hamper these efforts. Unlike most major defense acquisition programs, MDA programs are not required to demonstrate technologies in a relevant environment prior to system development, so decision makers will have to hold the program accountable for ensuring the technologies mature as intended.

Estimated Total Program Cost (fiscal years 2012 to 2016, research and development): $1,673.0 million

Next Major Program Event: System development start, fiscal year 2014

Program Office Comments: In commenting on a draft of this assessment, MDA noted the SM-3 Block IIB's primary mission is early intercept of long-range ballistic missiles. One system development contract will be competitively awarded in fiscal year 2014. MDA has identified key missile technologies and made investments to reduce development risks. Prior to system development, there will be a government-only system requirements review. MDA also provided technical comments, which were incorporated as appropriate.

Combat Rescue Helicopter (CRH)

The Air Force's Combat Rescue Helicopter (CRH) program, formerly called HH-60 Recapitalization, is an effort to replace aging HH-60G Pave Hawk helicopters. The CRH's primary mission is to recover personnel from hostile or denied territory; it will also conduct humanitarian, civil search and rescue, disaster relief, and noncombatant evacuation missions. The program is the second effort to replace the HH-60G. The first, the Combat Search and Rescue Replacement Vehicle (CSAR-X), was cancelled because of cost concerns in 2009.

Source: U.S. Air Force.

Current Status

The CRH program expects to receive its materiel development decision by February 2012. The Air Force expects that the CRH will be an existing production helicopter with modifications that utilize existing mature technologies or subsystems requiring limited integration. As a result, the program's acquisition strategy calls for it to bypass technology development and enter the acquisition process at system development. The Secretary of the Air Force endorsed the program's acquisition approach in April 2011, but requested that the program refine its fiscal year 2013 cost and schedule estimates before moving forward. The program office made these refinements through market research and requests for information from industry. The program plans to issue a request for proposal and award a contract in 2013. According to the program office, the CRH will undergo DOD's new pre–system development review to determine whether the program's plans are executable, affordable, and reflect sound business practices before a request for proposal is issued.

In order to address a critical shortfall in HH-60G aircraft, the Air Force has also initiated an Operational Loss Replacement (OLR) program, which will modify Army UH-60Ms to provide additional HH-60 aircraft to meet current fleet size requirements. These HH-60 aircraft are expected to remain in operation until the CRHs are fully deployed. CRHs are expected to begin being deployed on or before 2018.

Estimated Total Program Cost (fiscal years 2012 to 2016): $2,128.3 million
Quantity: 112

Next Major Program Event: Materiel development decision, February 2012

Program Office Comments: In commenting on a draft of this assessment, the Air Force generally concurred with our assessment, but stressed the fact that the CRH and OLR programs are two separate acquisition efforts. The OLR is designed to maintain the capability of the current HH-60 fleet, while the CRH is designed to provide improved capability in the future. The Air Force also provided technical comments, which were incorporated as appropriate.

Common Infrared Countermeasure (CIRCM)

The Army's CIRCM, the next generation of the Advanced Threat Infrared Countermeasures (ATIRCM), will be used with the Common Missile Warning System (CMWS) 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: U.S. Army.

Current Status

The CIRCM program entered technology development in January 2012 after earlier prototyping efforts did not produce a system mature enough to enter system development. The CIRCM subprogram began in 2009 when the Under Secretary of Defense for Acquisition, Technology and Logistics supported the Army's decision to restructure the ATIRCM/CMWS program. At that time, the Under Secretary determined that aircraft survivability equipment development needed better coordination of service efforts, more emphasis on competitive prototyping, and a greater focus on reducing ownership cost by increasing reliability. In June 2009, the Army received approval to award five contracts to provide prototype systems for testing. After testing the five prototypes, the Army concluded that the systems were not mature enough for entry into system development. The Army subsequently decided that the program should proceed with a technology development phase that will include additional prototyping efforts to further mature CIRCM technologies. The Army released the final request for proposal for the CIRCM technology development phase in February 2011 and proposals were due in May 2011. The Army awarded two contracts in January 2012. According to the Army, there are several risks for CIRCM in technology development, including immature technologies that could result in an inability to meet a key performance requirement and the weight of the system, which may be too heavy for small aircraft. The Army has mitigation plans in place to address these issues and plans to update its risk assessment once the winning contractors and their designs are known.

Estimated Total Program Cost: $3,448.9 million
Research and development: $754.8 million
Procurement: $2,694.1 million
Quantities: 1,076

Next Major Program Event: Technology development contract award, January 2012

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

Common Vertical Lift Support Platform (CVLSP)

The Air Force's Common Vertical Lift Support Platform (CVLSP) is expected to replace the current fleet of UH-1N helicopters with 93 vertical lift aircraft that can provide improved speed, range, and survivability. CVLSP will support a variety of missions including nuclear security operations and mass passenger transport in the National Capital Region. Initial operational capability for the CVLSP aircraft is planned for fiscal year 2015.

Source: U.S. Air Force.

Current Status

In May 2010, the CVLSP program received its materiel development decision and, in August 2011, the Air Force approved the program's acquisition strategy. The Air Force plans to use full and open competition to identify, select, and procure an in-production, nondevelopmental, commercial- or government-off-the-shelf aircraft. As a result, the program plans to bypass system development and enter the acquisition process at production. Air Force market research found that multiple aircraft currently in production could meet CVLSP requirements and industry has the capacity to produce the aircraft at the desired rates. Program officials noted that because all of the candidate aircraft are in production and operational use, their associated subsystems and critical technologies are considered mature. As a result, the Air Force expects that the program's total research and development cost will only be $33.5 million, primarily to support testing.

At the time the Air Force approved the CVLSP acquisition strategy, the program office was planning to issue a draft request for proposal in September 2011 and a final one in January 2012, award a contract in December 2012, and hold a low-rate initial production decision review in June 2013. However, the release of the draft request for proposal has been delayed indefinitely as the Air Force reviews all of its programs and budget in light of the fiscal constraints currently facing the entire federal government. According to program officials, senior Air Force leadership will decide if and when to release the draft request for proposal. The effect of the delay on the program's plans depends on the eventual timing of the release and the direction from Air Force leadership that accompanies it.

Estimated Total Program Cost: $3,626.3 million
Research and development: $33.5 million
Procurement: $3,561.1 million
Quantities: 93

Next Major Program Event: Release of the draft request for proposal, TBD

Program Office Comments: The program office concurred with this assessment.

DDG 51 Destroyer

The DDG 51 destroyer is a multimission surface ship designed to operate against air, surface, and subsurface threats. After an approximate 4-year production break, the Navy restarted Flight IIA production and plans to buy 10 ships between fiscal years 2010 and 2015. The Navy will begin buying a new version—Flight III—in fiscal year 2016. Flight III is expected to include the Air and Missile Defense Radar (AMDR)—which is being developed under a separate Navy program—and have an increased focus on ballistic and cruise missile defense.

Source: U.S. Navy.

Current Status

In 2011, the Navy awarded contracts for three Flight IIA ships with an option for a fourth ship to restart DDG 51 production. Construction of the first ship—DDG 113—began in July 2011. The production break resulted in fewer industrial base issues than the Navy expected; however, the amount budgeted for the first three restart ships is $1.8 billion (in constant fiscal year 2012 dollars) more than for the last three ships built. According to the Navy, the ships will not have significant design changes, but will carry an upgraded Aegis combat system, which is currently being developed. The upgrade is expected to enable limited simultaneous, integrated ballistic and cruise missile defense and is the most complex Aegis upgrade ever undertaken. Recent delays in the effort have increased the likelihood the program may still be resolving software defects when it is installed on DDG 113. Further, test plans show that the Navy will certify the upgrade is mission-ready without validating with simultaneous live-fire tests that it can perform its new integrated air and missile defense mission.

The Navy is still determining which technologies will be included on Flight III. To date, the Navy has identified AMDR as the only major technology upgrade for Flight III, and technical studies indicate that few of the technologies developed for the DDG 1000 program are likely to be included on it. AMDR may add significant design and construction risk to Flight III and limit future upgrades based on its size and power and cooling requirements. Program officials stated that a decision has not been made about AMDR's size, which will affect the ship's missile defense capabilities and how much its power and cooling capabilities need to be increased. Further, the Navy has not determined the level of oversight that the Flight III program will have or at which—if any—milestone the program will enter the DOD acquisition cycle.

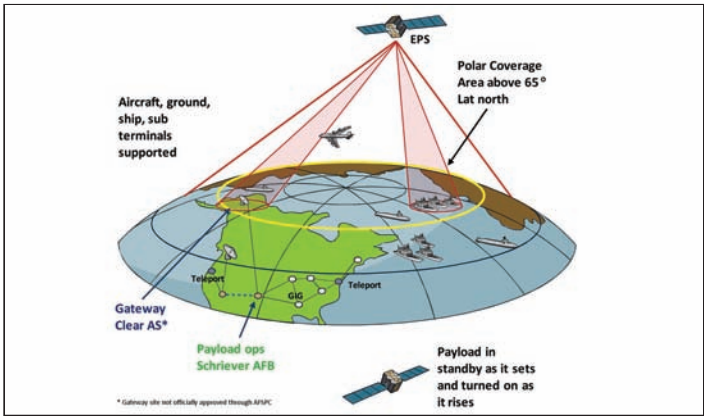
Estimated Total Program Cost (fiscal years 2010 to 2016): $17,755.6 million
Research and development: $797.6 million
Procurement: $16,958.0 million
Quantity: 11

Next Major Program Event: AMDR system development start, October 2012

Program Office Comments: In commenting on a draft of this assessment, the Navy stated that the last three ships built were part of a multiyear procurement, while the DDG 113 was a sole-source procurement and the next three ships were awarded through a limited competition, which may affect a comparison of their costs. Further, these ships, unlike earlier ones, include ballistic missile defense capability. The Navy also commented that the Aegis upgrade will be sufficiently mature to support DDG 113 shipbuilding milestones. The Navy also provided technical comments, which were incorporated as appropriate.

Enhanced Polar System (EPS)

The Air Force's Enhanced Polar System will 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 system. EPS consists of 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.



Source: LinQuest Corporation.

Current Status

The EPS program's entry into system development has been delayed by over 3 years, although the payload has moved forward with development activities to keep it on track with the scheduled launch of its classified host satellites. EPS was initiated in 2006 to fill the gap left by the cancellation of the Advanced Polar System. In 2007, the Under Secretary of Defense for Acquisition, Technology and Logistics directed the program to proceed to system development in order to synchronize the program's payload schedule with the host satellite production timeline. Payload development proceeded in 2008, but the program's entry into system development has been delayed. According to the program office, the latest delays have occurred because funding constraints required the program to reduce the capabilities of the control and planning segment and gateway and amend the EPS acquisition strategy. Once the revised acquisition strategy is approved, the program plans to award a development contract for the control and planning segment that would lead to a preliminary design review in the first quarter of fiscal year 2013 and a system development decision at the end of fiscal year 2013.

There is a risk that the payload will be on orbit before the control and planning segment is available. The payload, which consists of about 20 separate units such as processors and antennas, has been in development for several years and all of its critical technologies are mature. As each payload unit is flight qualified, they are delivered to the host for integration into the satellites, which are expected to be on-orbit in fiscal years 2015 and 2017. Program officials acknowledged that it will be a challenge to develop and build the control and planning segment, needed for the system to be fully functional, by the time the payloads reach orbit.

Estimated Total Program Cost: $1,530.0 million
Research and development: $1,468.3 million
Procurement: $61.7 million
Quantity: 2 payloads

Next Major Program Event: System development decision for control and planning segment and gateway, fourth quarter fiscal year 2013

Program Office Comments: The EPS program office provided technical comments, where were incorporated as appropriate.

Expeditionary Fighting Vehicle (EFV)

The Marine Corps' EFV was being developed to transport troops from ships offshore to inland locales at higher speeds and from longer distances than the Assault Amphibious Vehicle 7A1 (AAV 7A1), which it was supposed to replace. It was to have two variants—a troop carrier for 17 combat-equipped Marines and 3 crew members and a command vehicle to manage combat operations. In January 2011, the Secretary of Defense announced the cancellation of the EFV due to technology problems, development delays, and cost increases.

Source: U.S. Marine Corps.

Current Status

The EFV program has been cancelled and an official reported that the EFV contract will end in September 2012. Shutdown activities, which will cost about $200 million, are ongoing and will include harvesting technologies and conducting habitability, firepower, water speed, durability, and mine blast testing on EFV vehicles.

Despite the EFV's cancellation, the Marine Corps has determined that it still needs an amphibious assault vehicle with greater capabilities than the legacy AAV 7A1 and is conducting an analysis of alternatives to explore options for replacing that vehicle. In September 2011, DOD's Office of Cost Assessment and Program Evaluation issued guidance directing that this analysis include five options: the cancelled EFV (about $18 million per unit), a new amphibious vehicle, a new land-mission focused vehicle which will need to be transported from ship to the shore via another watercraft, upgrades to the legacy AAVs to address identified gaps in the vehicle's survivability, and upgrades to the legacy AAVs to address other capability gaps such as water and land mobility, networking, and lethality. The Marine Corps also noted that the analysis will consider relaxing the EFV's requirements to make the new solution more affordable. For example, the analysis assumes a reduction in the ship-to-shore launch distance from 25 nautical miles, which was required of the EFV, to a range of 12 to 25 nautical miles. A shorter launch distance would place Navy amphibious transport ships at greater risk to shore-based threats. The analysis of alternatives is expected to be complete before the end of fiscal year 2012.

Estimated Total Program Cost (through fiscal year 2011): $3,704.9 million

Next Major Program Event: EFV contract expiration, September 2012

Program Office Comments: The Marine Corps was provided a draft of this assessment and did not offer any comments.

F-22 Modernization Increment 3.2B

The Air Force's F-22A Raptor is the only operational fifth-generation air-to-air and air-to-ground fighter/attack aircraft. This aircraft integrates stealth; supercruise; and advanced avionics, maneuverability, and weapons in one platform. The Air Force established the F-22A modernization and improvement program in 2003 to add enhanced air-to-ground, information warfare, reconnaissance, and other capabilities and improve the reliability and maintainability of the aircraft. The Air Force is upgrading the F-22A fleet in four increments.

Source: U.S. Air Force.

Current Status

The first F-22A modernization increment has been fielded. Operational testing for the second increment was delayed between March and September 2011 because of the stand-down of the entire F-22 fleet after a fatal crash, test range unavailability, and a technical issue relating to ground support equipment. Increment 3.2A—the third increment—began developing software for electronic protection, combat identification, and Link 16 communication upgrades in November 2011, with fielding planned to begin in 2014. Program officials reported in December 2011 that increment 3.2A was slightly ahead of its current schedule.

The fourth program increment, increment 3.2B, is expected to begin system development as a separate major defense acquisition program in fiscal year 2013. This increment plans to field AIM-9X and AIM-120D missiles and upgrade electronic protection, targeting capabilities, and communication capabilities by 2017. The 3.2B increment will benefit from investments that have already been made in the modernization program, including requirements and risk-reduction analyses and the development of hardware needed to integrate new capabilities.

The Air Force identified three critical technologies for increment 3.2B. The two technologies that will be used to integrate the AIM-9X missile with the aircraft are in the early stages of development and have only been tested in a lab environment. The Air Force expects these technologies to be demonstrated in a relevant environment by the start of system development. The third technology, which is needed to improve the ability to locate ground targets, has already been demonstrated in a relevant environment.

Estimated Total Program Cost: $1,567.5 million
Research and development: $1,040.9 million
Procurement: $526.6 million
Quantity: 143
Note: The program cost is for increment 3.2B. The total cost estimate for all of F-22's modernization increments and improvements is $12.7 billion.

Next Major Program Event: System development start, December 2012

Program Office Comments: The Air Force provided technical comments, which were incorporated as appropriate.

Ground Combat Vehicle (GCV)

The Army's Ground Combat Vehicle (GCV) is the cornerstone of its combat vehicle modernization strategy. The first variant is intended to be the service's next infantry fighting vehicle, replacing a portion of the current Bradley fleet. The Army wants GCV to provide a full-spectrum capability to perform offensive, defensive, stability, and support operations; carry a 9-soldier squad; emphasize force protection; and be available within 7 years of beginning technology development.

Source: U.S. Army.

Current Status

In August 2011, the Under Secretary of Defense for Acquisition, Technology and Logistics approved the GCV program's entry into a 24-month technology development phase with the goals of reducing overall risk and achieving an affordable, feasible, and operationally effective preliminary design. During technology development, the Army plans to utilize a three-pronged approach that includes an updated analysis of alternatives; an assessment of selected nondevelopmental vehicles, such as an upgraded Bradley vehicle; and contractor efforts to build and demonstrate key subsystem prototypes. The Army awarded technology development contracts to two contractor teams. However, work could not begin until a bid protest from a third contractor team was resolved. The Army expects to have a preliminary design review within 18 months of beginning technology development and, at that point, according to an Army official, should be ready to determine whether GCV will be an entirely new vehicle or a modified existing vehicle.

In March 2011, we raised questions about the Army's strategy for the GCV program related to how urgently it is needed, the robustness of the analysis of alternatives, its cost and affordability, the plausibility of its schedule, and the maturity of the technologies to be used. DOD addressed some of these areas when it approved the program to enter technology development, but resolving others will be a major challenge for the Army. The Under Secretary of Defense for Acquisition, Technology and Logistics made approval of the program contingent upon the Army ensuring a procurement unit cost of $13 million per vehicle and a 7-year schedule for the first production vehicle to be delivered—both ambitious goals. The Army has encouraged contractors to use mature technologies in their designs, which we have found to be a key determinant to program success.

Estimated Total Program Cost: $31,589.9 million
Research and development: $6,789.7 million
Procurement: $24,800.2 million
Quantities: 30 (development), 1,874 (procurement)

Next Major Program Event: System development start, December 2013

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

Joint Light Tactical Vehicle (JLTV)

The Army and Marine Corps' Joint Light Tactical Vehicle 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. Two- and four- seat variants are planned with multiple mission configurations.

Source: Department of Defense.

Current Status

On the basis of the knowledge gained in technology development, the Army and Marine Corps made changes to JLTV requirements. In October 2008, the Army awarded three technology development contracts with the goal of defining requirements, reducing risks, and shortening the length of system development. The contractors delivered prototype vehicles in May 2010 and testing was completed in June 2011. On the basis of the results, the Army and Marine Corps concluded that the original JLTV requirements were not achievable and its cost would be too high. For example, the JLTV could not meet requirements for both protection levels and transportability because of weight. The services have relaxed part of the requirement to transport the vehicle by helicopter at high altitude and at certain temperatures, which will permit a heavier vehicle to be transported. As a result of the requirements changes, the Army and Marine Corps will shift some missions intended for JLTV to the HMMWV.

The JLTV program has also made changes to its acquisition strategy. The Army and Marine Corps had planned to follow a traditional acquisition approach and enter system development in January 2012. The services now plan to use a tailored approach that includes awarding contracts to up to three vendors to build 20 vehicles, extensively testing those vehicles, and proceeding to production. Contract award is scheduled for June 2012. Contractors will have 12 months to build and deliver their prototypes, after which the government will spend 15 months testing them. A decision to begin production is planned for second quarter fiscal year 2015. DOD sees this approach as saving time and money; however, it forgoes the activities typically done early in system development that demonstrate the product's design is mature and will meet requirements. As a result, the Army and Marine Corps are at risk of discovering that the vehicles are still not mature late in the program.

Estimated Total Program Cost: TBD

Next Major Program Event: Contract award, June 2012

Program Office Comments: In commenting on a draft of this assessment, the program stated that as requirements were adjusted to reflect more achievable and cost-effective thresholds, system development could be shortened by leveraging existing designs. The program will focus the selection criteria on mature designs that manage the risks. Robust testing will allow sufficient opportunities for contractors to address issues throughout testing. The program also provided technical comments, which were incorporated as appropriate.

Joint Tactical Radio System (JTRS) Ground Mobile Radios (GMR)

DOD's JTRS program was developing software-defined radios intended to interoperate with selected radios and increase communications and networking capabilities. The JTRS GMR program was developing radios for ground vehicles and the software needed to operate them. The JTRS GMR contract also included the development of the wideband networking waveform. In October 2011, DOD terminated the JTRS GMR program. It plans to pursue an alternative strategy to meet ground vehicle networking and communications requirements.

Source: Department of Defense.

Current Status

In October 2011, the JTRS GMR program was terminated when the Acting Under Secretary of Defense for Acquisition, Technology and Logistics decided not to certify it to continue after a Nunn-McCurdy unit-cost breach of the critical threshold. The Under Secretary attributed the unit-cost growth to a reduction in quantity, an inadequate analysis of the program's affordability at its inception, a series of contractor and program execution issues, and the addition of new information-assurance requirements. The Under Secretary also noted that it was unlikely that the JTRS GMR program could meet its requirements in an affordable manner and may not meet some requirements at all. The radio had performed poorly during testing, prompting the test unit to conclude that its development should end and it should not be fielded. Finally, an assessment of alternative options found that a competitive market had emerged with the potential to deliver radios that meet the Army's capability needs at a reduced cost.

In order to meet networking requirements for ground vehicles, DOD plans to pursue a two-pronged approach. First, the current JTRS GMR contractor will continue development through March 2012 when the term of the contract ends, which will allow for completion of the JTRS GMR's National Security Agency information assurance certification, its operating environment software, and the wideband networking waveform. Second, DOD established a new program to test and evaluate low-cost, nondevelopmental radios with reduced size, weight, and power with a plan to field them in fiscal year 2014. In November 2011, the Navy Space and Naval Warfare Systems Command, on behalf of the JTRS Joint Program Executive Office, released a draft request for proposal for this new program to seek input from industry, with the expectation that a formal solicitation will be released in February 2012.

Estimated Total Program Cost (through fiscal year 2011): $1,832.3 million

Next Major Program Event: NA

Program Office Comments: The JTRS Joint Program Executive Office was provided a draft of this assessment and did not offer any comments.

Nett Warrior

The Army's Nett Warrior program is an integrated situational awareness system for use during combat operations. It was to consist of a radio furnished by the government and several contractor-developed items including a hands-free display, headset, and computer. According to program officials, the program is being restructured to deliver useable increments of capability sooner and for less money. The Army now plans to procure a commercially developed system that is considerably smaller and lighter.

Source: U.S. Army.

Current Status

The Nett Warrior program is being restructured based on concerns about its affordability and performance in testing. The program was approved to enter technology development in February 2009 and planned to proceed directly to production in fiscal year 2011. The Army awarded cost-plus-fixed-fee contracts to three contractors for a suite of prototype equipment, which included a hands-free display, headset, computer, navigation equipment, antenna, and cables, that would eventually integrate with a government-furnished JTRS Rifleman radio. These prototypes underwent developmental testing and were evaluated in an October 2010 limited user test. Program officials indicated that a number of performance issues were revealed during testing and the size, weight, and power demands of the system resulted in it having little to no overall operational benefit. In September 2011, the Army decided to restructure the program, and program officials stated that a stop work order was issued for all three contractors.

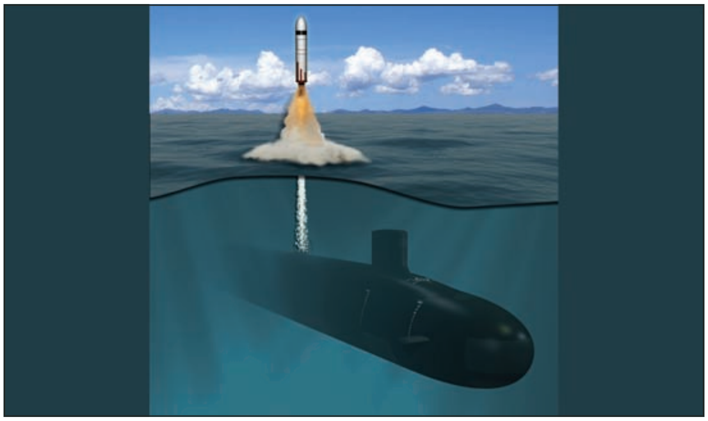
Program officials further stated that the Army now plans to provide soldiers with commercially based, smart phone–type devices connected to a JTRS Rifleman radio. According to the Army, moving to a commercial solution will significantly reduce the cost and weight of the Nett Warrior capability. Before the restructuring, the program was projected to cost $1.936 billion to develop and acquire 74,197 sets of equipment. Program officials indicate that the new system is projected to reduce costs by as much as 60 percent and, as a result, the program is no longer considered a major defense acquisition. The new system was evaluated in the Army's semiannual network integration evaluation that concluded in November 2011. The Army plans to utilize the results from this test to inform a competitive procurement, which will then be followed by additional testing and the planned deployment of an incremental capability in fiscal year 2013.

Estimated Total Program Cost: TBD

Next Major Program Event: Production decision, March 2012

Program Office Comments: In commenting on a draft of this assessment, the program office acknowledged the requirement changes the program has experienced, which serve to emphasize the potential benefits provided by commercially developed equipment solutions. The program office also provided technical comments, which were incorporated as appropriate.

Ohio-Class Replacement (OR)



Source: © 2010 General Dynamics Electric Boat.

The Navy's *Ohio*-class Replacement (OR) will replace the current fleet of *Ohio*-class ballistic missile submarines (SSBN) as they begin to retire in 2027. The Navy began research and development in 2008, 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 for the Vanguard SSBN. OR will initially carry the Trident II missile.

Current Status

The OR program began technology development in January 2011. Affordability has been an early focus of the program. Due to its high cost, Navy officials have stated the OR program could stress Navy shipbuilding budgets in the 2020 to 2030 time frame. Program officials stated that they are trying to reduce the average procurement unit cost from an estimated $5.6 billion to $4.9 billion (in fiscal year 2010 dollars). The program is considering procuring OR as part of a block buy with the *Virginia*-class submarine to reduce procurement costs by an estimated 13 percent, and is lining up its production schedule to match that program in case this option is pursued. The Navy also decided to use 16 87-inch diameter tubes per submarine, which, while fewer than the *Ohio*-class, is expected to reduce costs while meeting the anticipated future strategic requirement based on arms reduction trends. According to the program, a four-way competition is ongoing to develop prototype tubes and efficient manufacturing processes for outfitting these tubes into the hull, including the use of a “quad pack” configuration that could reduce cost and construction time.

According to Navy officials, they are currently defining requirements and conducting early design work for the program with Electric Boat as the design agent responsible for the overall ship design and Huntington Ingalls Industries as a subcontractor. For example, the Navy is planning to use a new X-stern aft control surface configuration for steering the submarine, pending successful testing. This design is expected to provide the desired maneuverability and increase maintainability. OR may also use electric propulsion, which would help improve the submarine's stealthiness because it uses fewer moving parts. Program officials said they plan to have the three-dimensional design complete prior to starting construction on the lead ship to minimize rework, delays, and the potential for cost growth.

Estimated Total Program Cost: $90,433.5 million
Research and development: $11,142.8 million
Procurement: $79,290.7 million
Quantity: 12

Next Major Program Event: Preliminary design review, March 2014

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

Patriot/Medium Extended Air Defense System (MEADS) Combined Aggregate Program (CAP) Fire Unit

The Army's Patriot/Medium Extended Air Defense System (MEADS) Combined Aggregate Program was a ground-mobile system intended to provide low- to medium-altitude air and missile defense to counter tactical ballistic missiles, cruise missiles, or other air-breathing threats. It included Patriot missile upgrades with a new battle management system, launchers, radars, and reloaders. MEADS is being codeveloped by the United States, Germany, and Italy.

Source: Lockheed Martin/MBDA/LFK (MEADS International).

Current Status

In February 2011, the Office of the Secretary of Defense proposed ending U.S. involvement in the MEADS program before development had been completed. In making its decision, DOD cited lingering concerns about the high degree of risk in the program and its affordability. DOD still plans to provide $803.7 million in funding through fiscal year 2013 for design and development activities, as required by the terms of its existing memorandum of understanding with its international partners.

Since MEADS development cannot be completed with the funding currently provided under the memorandum of understanding, the program office will instead work towards a demonstration of capabilities, which includes two planned flight tests. Much of the remaining development effort will be focused on the multifunction fire control radar, launcher, and battle management system. Program officials stated that launcher development is on track, but the battle management software is delayed and the multifunction radar still faces hardware challenges. Further delays in the development of these items could cause the program to reduce the number of planned flight tests to one. The program has stopped developing the system support vehicle, MEADS network radio, and reloader. It has also curtailed development of the surveillance radar, but plans to provide a low-cost prototype with 50 percent of the planned active electronics of the full radar design for the demonstration. Program officials stated that the surveillance radar is the most important item for the United States because it can potentially be leveraged for other systems. Program elements, such as the near-vertical launcher and a cooling technology for rotating phased-array radars, also might prove useful on other air and missile defense programs.

Estimated Total Program Cost (through fiscal year 2013): $3,280.4 million

Next Major Program Event: First flight test, November 2012

Program Office Comments: In commenting on a draft of this assessment, the Army stated that limited activities may continue into fiscal year 2014 and beyond. For example, international and U.S.-only contract closeout activities and data archiving may extend beyond fiscal year 2013. Additionally, the European partners may continue MEADS element development, which would require U.S. support through foreign military sales.

Presidential Helicopter (VXX)

The Navy's VXX program is intended to develop a presidential helicopter replacement fleet that will provide transportation for the President, Vice President, heads of state, and others as directed. The VXX fleet will replace the current fleet of VH-3D and VH-60N helicopters. The initial replacement effort, the VH-71, was terminated in June 2009 due to excessive cost growth and schedule delays, but the requirement to field a replacement remained. The Navy is also taking steps to extend the life of the current VH-3D/VH-60N fleet and streamline the VXX acquisition strategy.

Source: U.S. Navy.

Current Status

In June 2010, the VXX program received its materiel development decision and began assessing alternatives to replace the existing VH-3D/VH-60N helicopter fleet. The Navy completed and provided to DOD the results of its analysis of alternatives in March 2011. DOD officials reviewed the results and determined that the Navy's analysis study did not find an acceptable—that is, cost-effective—solution. The Office of the Secretary of Defense (OSD) and the Navy subsequently decided to update the analysis of alternatives using an acquisition strategy that might result in a more timely and affordable program using additional guidance provided by OSD in December 2011. This strategy is based on leveraging mature technologies that will be developed outside of the VXX program before including them on VXX aircraft. DOD officials stated that the new analysis of alternatives will also include revised configurations that will satisfy a refined set of requirements. The program has been delayed until this analysis is completed.

As a result of the termination of the VH-71 and delay of the VXX effort, the legacy Presidential helicopter fleet will be upgraded and its service life will be extended. The upgrades will address many, but not all, of the capability gaps of the legacy fleet. The Navy plans to conduct a service life extension program (SLEP) on the legacy fleet that will extend their service life by 4,000 hours. The VH-3D and VH-60N will receive these modifications, including structural enhancements, during their routine overhaul cycles. The SLEP will allow the aircraft to operate until replacement aircraft are fielded, which the Navy wants to accomplish as quickly as possible as it has stated that the capability shortfalls of the current fleet cannot be otherwise overcome.

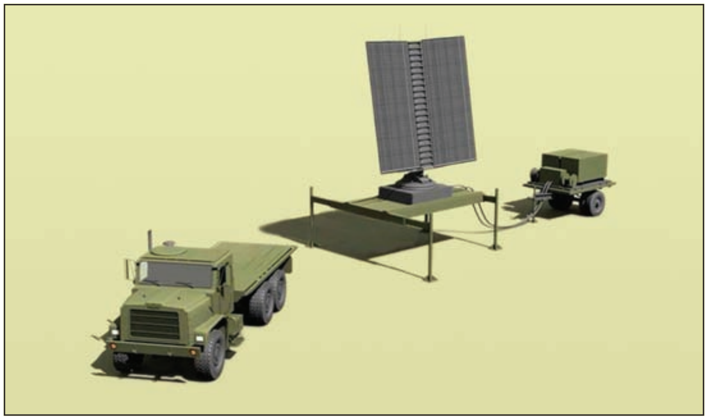
Estimated Total Program Cost: TBD

Next Major Program Event: Revised VXX analysis of alternatives, TBD

Program Office Comments: The program office concurred with the assessment and provided technical comments, which were incorporated as appropriate.

Three Dimensional Expeditionary Long Range Radar (3DELRR)

The Air Force's 3DELRR will be the long-range, ground-based sensor for detecting, identifying, tracking, and reporting aircraft and missiles for the Joint Forces Air Component Commander. It will provide real-time data and support a range of expeditionary operations in all types of weather and terrain. It is being acquired to replace the Air Force's AN/TPS-75 radar systems. The Marine Corps is considering 3DELRR as a potential replacement to the AN/TPS-59 to support the Marine Air-Ground Task Force Commander.



Source: U.S. Air Force.

Current Status

The 3DELRR program entered technology development in May 2009. The Air Force awarded two contracts for competing prototypes and plans to conduct a full and open competition and award a single cost-plus incentive fee contract for additional technology development activities. These activities include defining the preliminary system design, conducting a preliminary design review, producing a functioning system prototype for a capability demonstration, and other risk-reduction activities. The contract will also include options for system development, which is expected to begin in the first quarter of fiscal year 2014, and initial production. The program office reported that it has delayed the release of the request for proposal for this contract indefinitely due to its ongoing revision of the 3DELRR acquisition strategy. The revision is focused on the program's affordability and plans for competition.

The 3DELRR program is focused on reducing technical risk before beginning system development and has identified eight critical technologies. In April 2011, an independent review team reported that the program successfully demonstrated its critical technologies between both prototypes, though program officials noted the technologies still need to be integrated and demonstrated as a system. The program's technology development strategy calls for these technologies to be nearing maturity and demonstrated in a relevant environment at the start of system development. The program also expects to complete a preliminary design review prior to system development. Initial operational capability for the radar is targeted for approximately 2020.

Estimated Total Program Cost: $2,124.0 million
Research and development: $754.6 million
Procurement: $1,369.4 million (Air Force only)
Quantities: 35 (Air Force only)

Next Major Program Event: Contract award, TBD

Program Office Comments: The program office concurred with this assessment.

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

The Navy's UCLASS is expected to enable a single aircraft carrier to conduct sustained operations including intelligence, surveillance, and reconnaissance (ISR), as well as targeting, strike, and bomb damage assessment. The system will address a gap in persistent sea-based ISR with precision strike capabilities. It includes upgrades to carrier infrastructure and systems, upgrades to existing command and control systems, and an unmanned aerial vehicle.

PROGRAM EXECUTIVE OFFICE
UNMANNED AVIATION & STRIKE WEAPONS

Source: U.S. Navy.

Current Status

The UCLASS program received its materiel development decision in July 2011. The program aims to achieve a limited initial capability in 2018 using existing capabilities that the Navy believes can be leveraged to support a UCLASS platform. The feasibility of this strategy will depend, in part, on the success of Navy's Unmanned Combat Air System Aircraft Carrier Demonstration (UCAS-D). The UCAS-D program's scope consists of design, development, integration, and demonstration of a carrier-suitable, low-observable, unmanned combat air system platform in support of a future acquisition program. UCAS-D will demonstrate carrier operations, including autonomous aerial refueling, as well as mature critical technologies needed to operate and integrate the aircraft with the ship. The analysis of alternatives for the UCLASS program, which was planned to be completed in January 2012, assumes that the UCAS-D program is successful in maturing technologies required to conduct launch, recovery, and carrier-controlled airspace operations and that the technologies can be applied to the UCLASS. Although the UCAS-D aircraft is not scheduled to demonstrate a carrier landing until 2013, F/A-18 flight test points from June 2011 have demonstrated the unmanned landing technology that will be incorporated into the UCLASS design. The program is considering cost and performance trade-offs such as endurance, payload, speed, sensors, and survivability to ensure the system is affordable and can provide limited initial capability by 2018. The analysis of alternatives will also likely address options for incrementally growing capabilities over time through the use of modular ISR and precision strike mission packages. Officials stated that it is critical that a request for proposal be released in fiscal year 2012 for the program to achieve a 2018 limited initial capability.

Estimated Total Program Cost: TBD
Research and development (fiscal years 2012 to 2016): $2,422.7 million
Quantity: TBD

Next Major Program Event: Technology development start, September 2012

Program Office Comments: In commenting on a draft of this assessment, the Navy stated that UCLASS system design is informed by UCAS-D activities and successful UCAS-D surrogate carrier tests have proven the technologies that inform the UCLASS carrier and system specifications. These specifications support the UCLASS request for proposal release in fiscal year 2012. The President's Budget for Fiscal Year 2013 adjusts the schedule and associated funding to provide an intial capability by 2020 instead of 2018. The Navy also provided technical comments, which were incorporated as appropriate.

Agency Comments and Our Evaluation

DOD provided written comments on a draft of this report. The comments are reprinted in appendix VI. We also received technical comments from DOD, which have been addressed in the report as appropriate.

In its comments, DOD stated it appreciates our efforts to develop improved methods and metrics but, while it does not disagree with the data used, still does not fully agree with those methods and metrics. In particular, DOD states that the aggregate cost growth measures in the report fail to adequately address when, why, and how cost growth occurred. Specifically, DOD stated that the report does not make obvious in the aggregate measures or discussion that the portfolio changes every year. In addition, DOD commented that the cost of programs often increase or decrease for reasons other than overly optimistic planning, faulty estimating, or poor execution, such as changing requirements, funding incremental upgrades, changing inventory goals, and adjustments to production rates.

We believe the report includes observations that directly address each of these areas. We report the aggregate cost growth for DOD's 2011 portfolio of major defense acquisition programs over the last year, the past 5 years, and since programs' first full estimates. Our assessment also makes a number of observations that seek to determine the reasons for that aggregate cost growth, including examining how much of the procurement cost growth in the past year was due to changes in quantities and identifying the link between development cost growth for programs in production and incremental upgrades to these systems. Finally, the report includes analysis of how the portfolio has changed over the past year, how it is likely to change in the next fiscal year, and how this may affect both the number of programs and cost of DOD's portfolio of major defense acquisition programs.

We are sending copies of this report to the Secretary of Defense; the Secretaries of the Army, Navy, and Air Force; the Director of the Office of Management and Budget; and interested congressional committees. In addition, the report will be made available at no charge on the GAO Web site at http://www.gao.gov.

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

Michael J. Sullivan
Director, Acquisition and Sourcing Management

List of Committees

The Honorable Carl Levin
Chairman
The Honorable John McCain
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Daniel Inouye
Chairman
The Honorable Thad Cochran
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Howard P. McKeon
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable C.W. Bill Young
Chairman
The Honorable Norman D. Dicks
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I

Scope and Methodology

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

This report contains observations on the cost and schedule performance of the Department of Defense's (DOD) fiscal year 2011 major defense acquisition program portfolio. To develop these observations, we obtained and analyzed 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 refer to programs with SARs dated December 2010 as the 2011 portfolio. We converted cost information to fiscal year 2012 dollars using conversion factors from the DOD Comptroller's National Defense Budget Estimates for Fiscal Year 2012 (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 2012 dollars. To calculate cost remaining to completion we used funding stream data obtained from DAMIR on the programs in the 2011 portfolio to determine what funds had been allocated in prior years for all activities and how much funding is required for the program to complete its acquisition. The Missile Defense Agency's (MDA) Ballistic Missile Defense System (BMDS) is excluded from our analysis of the 2011 portfolio.

We also collected and analyzed data on the composition of DOD's major defense acquisition program portfolio. To determine changes in that portfolio, we compared the programs that issued SARs in December 2010 with the list of programs that issued SARs in December 2009. To assess the cost effect of changes to the major defense acquisition portfolio, we calculated the estimated total acquisition cost for the six programs exiting the portfolio and for the four programs entering the portfolio. To project the number and cost of programs expected to be in the 2012 portfolio, we used data from the December 2010 and September 2011 SARs to identify the programs leaving the portfolio and their estimated cost. We used data from DOD's 2011 Major Defense Acquisition Program list, program offices, and DOD's fiscal year 2012 budget request to estimate the number and cost of programs expected to enter the 2012 portfolio.

To compare the cost of major defense acquisition programs over the past year, 5 years, and from first full estimates, we collected data from December 2010, December 2009, and December 2005 SARs; acquisition

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[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.

program baselines; and program offices. We retrieved data on research, development, test, and evaluation; procurement; and total acquisition cost estimates for the 96 major defense acquisition programs in the 2011 portfolio. We divided some SAR programs into smaller elements, because DOD reports performance data on them separately, resulting in a total of 99 programs and subelements. We analyzed the data to determine the change in research and development, procurement, and total acquisition costs from the first full estimate, generally development start, to the current estimate. 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 be different than the original baseline contained in DOD SARs. When comparable cost and schedule data were not available for programs, we excluded them from the analysis. To calculate cost growth incurred over the past year, from 2010 to 2011, we calculated the difference between the December 2009 and December 2010 SARs for programs older than 1 year. For programs less than a year old, we calculated the difference between December 2010 and first full estimates. We converted all dollar figures to fiscal year 2012 constant dollars. We took a similar approach for calculating cost growth incurred from 2006 to 2011. We also obtained schedule information and calculated the cycle time from program start to initial operational capability; delay in obtaining initial operational capability; and the delay in initial capability as a percentage of total cycle time. Finally, we extracted data on program acquisition unit cost to determine whether a program's buying power had increased or decreased.

To calculate the amount of procurement cost growth attributable to quantity changes, we isolated the change in procurement quantities and the prior average procurement unit cost for programs over the past year. 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. An average procurement unit cost was not included in last year's SAR for the Littoral Combat Ship program. We calculated an average procurement unit cost for the program using the procurement quantities and funding up through fiscal year 2010 included in this year's SAR.

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, less than a 10 percent increase over the past 5 years, and less than a 15 percent increase from first full estimates using data from December 2010, December 2009, and December 2005 SARs; acquisition program baselines; and program offices. For programs that began as non–major defense acquisition programs, the first full estimate we used as a baseline may be different than the original baseline contained in DOD SARs. For programs with multiple subprograms presented in the SARs we calculated the net effect of the subprograms to reach an aggregate program result.

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 our purposes.

Analysis of Selected DOD Programs Using Knowledge-Based Criteria

Our analysis of how well programs are adhering to a knowledge-based acquisition approach focuses on 37 major defense acquisition programs that are 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 eight programs that entered these key acquisition points in 2011 and evaluated their adherence to knowledge-based practices. 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.

Programs in our assessment were in various stages of the acquisition cycle, and not all of the programs provided knowledge information for each point. Programs were not included in our assessments if relevant decision or knowledge data were not available. For each decision point, we summarized knowledge attainment for the number of programs with data that achieved 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 making a production decision. Additional information on how we collected these data is found in the product knowledge assessment section of this appendix. See appendix IV for a list of these practices.

Analysis of Acquisition Reform Implementation

To determine how DOD has begun to implement acquisition reforms, we obtained and analyzed the revised DOD 5000.02 acquisition instruction, the Weapon Systems Acquisition Reform Act of 2009, and the September 14, 2010, Under Secretary of Defense for Acquisition, Technology and Logistics memorandum on better buying power as well as the subsequent memorandums clarifying and implementing that guidance.

We analyzed data from surveys received from the 37 active and 16 future major defense acquisition programs in our assessment to determine the extent to which programs were implementing requirements for holding systems engineering reviews; developing competitive prototypes; maturing critical technologies; considering trade-offs among cost, schedule, and performance objectives before development start; and establishing affordability targets and “should cost” analyses. We also collected information on whether these programs are planning to incorporate competition into their acquisition strategies.[2]

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[2] The statutory requirement is that the acquisition strategy for each major defense acquisition program include measures to ensure competition, or the option of competition, throughout the life cycle of the program. Weapon Systems Acquisition Reform Act of 2009, Pub. L. No. 111-23, § 202. The survey question with respect to this requirement for major defense acquisition programs read “Does the program’s acquisition strategy call for competition between Milestone B and the completion of production?” For future programs the question read “Does the program’s technology development strategy or acquisition strategy call for competition between Milestone B and the completion of production?” When programs answered “no” to the question, we interpreted that answer to mean that the program is not planning to incorporate competition, or the option of competition, after development start into the acquisition strategy.

To collect data from future major defense acquisition programs—including cost and schedule estimates, technology maturity, and planned implementation of acquisition reforms—we distributed an electronic survey to 22 programs planning to become major defense acquisition programs and enter system development or bypass system development and start production. Both the surveys for current and future major defense acquisition programs were sent by e-mail in an attached Microsoft Word form that respondents could return electronically. We received responses from August to October 2011. During the course of our review, we dropped six future programs from this analysis; four because of schedule changes that prevented them from entering technology development in 2011, one due to program cancellation, and one because the program did not respond fully to our data request. Therefore, our assessment of future major defense acquisition programs consists of 16 programs that will likely become major defense acquisition programs and are nearing system development start or proceeding directly to a production decision.

To ensure the reliability of the data collected through our surveys, we took a number of steps to reduce measurement error, nonresponse error, and respondent bias. These steps included conducting two pretests for the future major defense acquisition program survey and three pretests for the major defense acquisition program survey by phone 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 surveys.

To determine the amount DOD plans to invest in future major defense acquisition programs before entering system development or, for those planning to bypass system development, production, we collected budget data from the President's Budget for Fiscal Years 2007 through 2012 for each of the 16 future major defense acquisition programs we reviewed. For each program, we summed all planned funding from program start through, but not including, the fiscal year of the planned start of system development or production. We obtained the planned start date of system development from the survey we submitted to 16 future major defense acquisition programs or other program office documentation. For two programs that were planning to bypass system development, we used the planned date of production start. For the 92 current major defense acquisition programs that reported a system development or production start date in their December 2010 SAR, we used annual funding stream data from DAMIR to calculate the investment made in each program from program start through, but not including, the fiscal year of the start of system development or production start for programs that bypassed system development. We converted both sets of numbers to fiscal year 2012 constant dollars using conversion factors from the DOD Comptroller's National Defense Budget Estimates for Fiscal Year 2012 (table 5-9).

Individual Assessments of Weapon Programs

In total, this report presents individual assessments of 68 weapon programs. A table listing these programs is found in appendix VII. Out of these programs, 48 are captured in a two-page format discussing technology, design, and manufacturing knowledge obtained and other program issues. Thirty-seven of these 48 two-page assessments are of major defense acquisition programs, most of which are in development or early production; 5 assessments are of elements of MDA's BMDS; and 6 assessments are of programs that were projected to become major defense acquisition programs during or soon after our review. The remaining 20 programs are described in a one-page format that describes their current status. These programs include 14 future major defense acquisition programs, 2 major defense acquisition programs that are well into production, 1 element of MDA's BMDS, and 3 major defense acquisition programs that were recently terminated. 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 68 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 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 MDA programs that do not follow the standard DOD acquisition model but instead develop systems' capabilities incrementally, we identify the key technology development efforts that lead to an initial capability.

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 2011 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 2012 dollars. We converted cost information to fiscal year 2012 dollars using conversion factors from the DOD Comptroller's National Defense Budget Estimates for Fiscal Year 2012 (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 2012 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.

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 surveys submitted by programs; however, not every program had responses to each element of the data-collection instrument or survey. We also reviewed pertinent program documentation and discussed the information presented on the data-collection instrument and survey with program officials as necessary.

To assess a program’s readiness to enter system development, we collected data on critical technologies and early design reviews. To assess technology maturity, we asked program officials to apply a tool, referred to as Technology Readiness Levels (TRL), for our analysis. The National Aeronautics and Space Administration originally developed TRLs, and the Army and Air Force science and technology research organizations use them to determine when technologies are ready to be handed off from science and technology managers to product developers. TRLs are measured on a scale from 1 to 9, beginning with paper studies of a technology’s feasibility and culminating with a technology fully integrated into a completed product. See appendix V for TRL definitions. Our best-practices work has shown that a TRL 7—demonstration of a technology in a realistic environment—is the level of technology maturity that constitutes a low risk for starting a product development program.[3] For shipbuilding programs, we have recommended that this level of maturity be achieved by the contract award for detailed design.[4] In our assessment, the technologies that have reached TRL 7, a prototype demonstrated in a realistic 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 a realistic environment—space. In addition, 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.[5] In most cases, we did not verify or validate the percentage of engineering drawings provided by the program office. We clarified the

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

[4] 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).

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

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.[6] 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.[7] 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 subthread 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 subthread—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 development testing of a fully configured, production-representative prototype in its intended environment. We compared this

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[6] GAO-09-322.

[7] GAO-02-701.

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 August 2011 to March 2012, 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.

Changes in DOD's 2011 Portfolio of Major Defense Acquisition Programs over Time

Table 6 shows the change in research and development cost, procurement cost, total acquisition cost, and average delay in delivering initial operational capability for the Department of Defense's (DOD) 2011 portfolio of major defense acquisition programs. The table presents changes that have occurred on these programs in the last year, the last 5 years, and since their first full cost and schedule estimates.

Table 6: Changes in DOD's 2011 Portfolio of Major Defense Acquisition Programs over Time

Fiscal year 2012 dollars in billions

	1 year comparison (2010 to 2011)	5 year comparison (2006 to 2011)	Since first full estimate (baseline to 2011)
Increase in total research and development cost	$14 billion 4 percent	$39 billion 14 percent	$113 billion 54 percent
Increase in total procurement cost	$61 billion 5 percent	$192 billion 19 percent	$321 billion 36 percent
Increase in total acquisition cost	$74 billion 5 percent	$233 billion 17 percent	$447 billion 40 percent
Average delay in delivering initial capabilities	1 month 2 percent	9 months 11 percent	23 months 32 percent

Source: GAO analysis of DOD data.

Notes: Data were obtained from DOD's Selected Acquisition Reports. In a few cases data were obtained directly from program offices. Not all programs had comparable cost and schedule data and these programs were excluded from the analysis where appropriate. Portfolio performance data do not include costs of developing Missile Defense Agency elements. Total acquisition cost includes research and development, procurement, acquisition operation and maintenance, and system-specific military construction costs.

Current and First Full Cost Estimates for DOD's 2011 Portfolio of Major Defense Acquisition Programs

Table 7 contains the current and first full total acquisition cost estimates (in fiscal year 2012 dollars) for each program or element in the Department of Defense's (DOD) 2011 major defense acquisition program portfolio. We excluded elements of the Missile Defense Agency's Ballistic Missile Defense System because comparable current and first full cost estimates were not available. For each program we show the percent change in total acquisition cost from the first full estimate, as well as over the past year and 5 years.

Table 7: Current Cost Estimates and First Full Cost Estimates for DOD's 2011 Portfolio of Major Defense Acquisition Programs

Fiscal year 2012 dollars in millions

Program	Current total acquisition cost	First full total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
Advanced Extremely High Frequency (AEHF) Satellite	$14,083	$6,370	121.1%	7.4%	106.6%
Advanced Threat Infrared Countermeasure/Common Missile Warning System (ATIRCM/CMWS)	4,853	3,414	42.2	1.7	-11.6
AGM-88E Advanced Anti-Radiation Guided Missile (AARGM)	1,902	1,601	18.8	2.7	20.7
AH-64D Longbow Apache	14,773	6,132	140.9	0.3	34.8
AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM)	23,582	10,931	115.7	-2.8	38.2
AIM-9X/Air-to-Air Missile	3,750	3,144	19.3	2.9	12.5
Airborne and Maritime/Fixed Station Joint Tactical Radio System (AMF JTRS)	8,221	8,154	0.8	-1.4	0.8
Airborne Signals Intelligence Payload (ASIP) - Baseline	554	347	59.5	-0.1	NA
Apache Block IIIA (AB3A)	10,737	7,242	48.3	0.0	48.3
Apache Block IIIB New Build	2,215	2,370	-6.5	-6.5	-6.5
Army Integrated Air & Missile Defense (Army IAMD)	5,529	5,029	9.9	9.9	9.9
B-2 Extremely High Frequency SATCOM Capability, Increment 1	625	710	-11.9	-0.4	-11.9
B-2 Radar Modernization Program (RMP)	1,284	1,339	-4.1	-3.1	2.3
Black Hawk (UH-60M)	25,169	12,970	94.1	13.0	19.9

(Continued From Previous Page)

Fiscal year 2012 dollars in millions

Program	Current total acquisition cost	First full total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
Block IV Tomahawk (Tactical Tomahawk)	6,943	2,116	228.1	-0.1	54.8
Broad Area Maritime Surveillance (BAMS) Unmanned Aircraft System (UAS)	13,052	12,848	1.6	-1.3	1.6
C-130 Avionics Modernization Program (AMP)	6,204	4,132	50.1	1.0	25.7
C-130J Hercules	15,397	949	1522.5	-1.0	79.5
C-27J Spartan	2,260	3,912	-42.2	13.2	-42.2
C-5 Avionics Modernization Program (AMP)	1,282	1,103	16.2	-4.3	30.1
C-5 Reliability Enhancement and Reengining Program (RERP)	7,442	10,905	-31.8	-0.2	-29.3
CH-47F Improved Cargo Helicopter (CH-47F)	14,475	3,220	349.6	5.4	16.0
CH-53K - Heavy Lift Replacement	22,440	16,557	35.5	0.9	35.6
Chemical Demilitarization-Assembled Chemical Weapons Alternatives (Chem Demil-ACWA)	10,173	2,642	285.0	26.2	118.3
Chemical Demilitarization-U.S. Army Chemical Materials Agency (Chem Demil-CMA)	27,743	15,542	78.5	-4.0	-3.5
Cobra Judy Replacement (CJR)	1,825	1,631	11.9	0.1	12.6
Cooperative Engagement Capability (CEC)	5,209	2,943	77.0	1.4	2.5
CVN 78 Class	33,994	35,574	-4.4	-2.0	4.0
DDG 1000 Destroyer	20,986	34,800	-39.7	4.4	-41.7
DDG 51 Destroyer	101,819	15,186	570.5	6.3	29.3
E-2D Advanced Hawkeye (E-2D AHE)	17,747	14,752	20.3	-1.9	19.9
EA-18G Growler	11,411	8,976	27.1	-3.1	22.7
Expeditionary Fighting Vehicle (EFV)	3,705	9,157	-59.5	-74.0	-69.7
F/A-18E/F Super Hornet	57,805	81,732	-29.3	4.3	12.5
F-22 Raptor	79,152	91,291	-13.3	0.8	6.1
F-35 Lightning II (Joint Strike Fighter)	326,535	213,708	52.8	13.4	34.1
Family of Advanced Beyond Line-of-Sight Terminals (FAB-T)	4,503	3,188	41.2	12.9	41.2

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Fiscal year 2012 dollars in millions

Program	Current total acquisition cost	First full total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
Family of Medium Tactical Vehicles (FMTV)	20,048	10,447	91.9	-7.3	13.7
Force XXI Battle Command Brigade and Below (FBCB2)	4,147	2,827	46.7	-0.7	51.8
Global Broadcast Service (GBS)	1,152	576	100.0	1.4	32.7
Global Hawk (RQ-4A/B)	13,992	5,392	159.5	1.5	68.4
Global Positioning System (GPS) III	4,332	3,941	9.9	3.1	9.9
Guided Multiple Launch Rocket System (GMLRS)	5,827	1,768	229.5	-0.4	-57.5
H-1 Upgrades (4BW/4BN)	12,557	3,627	246.3	4.3	55.5
HC/MC-130 Recapitalization Program	13,091	8,364	56.5	56.5	56.5
High Mobility Artillery Rocket System (HIMARS)	2,130	4,361	-51.2	-1.3	-35.8
Increment 1 Early-Infantry Brigade Combat Team	1,277	3,235	-60.5	-59.1	-60.5
Integrated Defensive Electronic Countermeasures (IDECM)	2,379	2,177	23.3	17.1	23.3
Integrated Defensive Electronic Countermeasures (IDECM) Blocks 2/3	1,558	1,483	5.0	0.2	5.0
Integrated Defensive Electronic Countermeasures (IDECM) Block 4	822	694	18.3	16.9	18.3
Joint Air-to-Surface Standoff Missile (JASSM)	7,509	2,318	224.0	2.7	49.9
Joint Direct Attack Munition	6,578	3,419	92.4	1.6	11.6
Joint High Speed Vessel (JHSV)	3,674	3,636	1.0	-1.3	1.0
Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS)	7,858	6,666	17.9	4.9	15.3
Joint Mine Resistant Ambush Protected (MRAP)	41,585	23,136	79.7	12.6	79.7
Joint Precision Approach and Landing System (JPALS)	983	1,012	-2.9	-0.3	-2.9
Joint Primary Aircraft Training System (JPATS)	5,724	3,725	53.7	-3.0	-0.3
Joint Standoff Weapon (JSOW)	5,589	7,947	-55.4	6.0	19.1

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Fiscal year 2012 dollars in millions

Program	Current total acquisition cost	First full total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
Joint Standoff Weapon (JSOW) Baseline	2,269	2,856	-20.6	1.3	1.3
Joint Standoff Weapon (JSOW) Unitary	3,321	5,091	-34.8	4.7	17.8
Joint Tactical Radio System (JTRS) Ground Mobile Radios (GMR)	16,414	17,422	-5.8	1.9	0.6
Joint Tactical Radio System (JTRS) Handheld, Manpack, and Small Form Fit (HMS)	5,382	10,037	-46.4	10.8	-47.4
Joint Tactical Radio System (JTRS) Network Enterprise Domain (NED)	2,073	981	111.4	2.4	7.4
KC-130J	9,389	9,485	-1.0	-1.0	-1.0
Large Aircraft Infrared Countermeasures (LAIRCM)	459	403	13.8	-0.5	13.8
Lewis and Clark Class (T-AKE) Dry Cargo/Ammunition Ship	6,605	5,283	25.0	-1.2	37.0
LHA Replacement Amphibious Assault Ship	10,095	3,180	217.4	55.7	217.4
Light Utility Helicopter (LUH), UH-72A Lakota	2,000	1,811	10.4	0.1	10.6
Littoral Combat Ship (LCS)	32,868	2,244	NA	NA	NA
LPD 17 Amphibious Transport Dock	18,674	11,712	59.4	0.2	38.1
M982 155mm Precision Guided Extended Range Artillery Projectile (Excalibur)	1,813	4,776	-62.0	-26.7	-19.2
MH-60R Multi-Mission Helicopter	14,703	5,536	165.6	1.0	24.2
MH-60S Fleet Combat Support Helicopter	8,417	3,508	139.9	-0.3	2.2
Mobile User Objective System (MUOS)	6,978	6,721	3.8	0.7	17.5
MQ-1C UAS Gray Eagle	5,159	1,015	408.2	2.0	159.9
Multifunctional Information Distribution System (MIDS)	3,024	1,304	131.8	1.4	19.7
Multi-Platform Radar Technology Insertion Program (MP-RTIP)	1,427	1,796	-20.6	3.1	-17.7
National Airspace System (NAS)	1,658	868	90.9	2.2	5.6

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Fiscal year 2012 dollars in millions

Program	Current total acquisition cost	First full total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
National Polar-orbiting Operational Environmental Satellite System (NPOESS)	7,272	6,683	8.8	13.6	-47.3
Navstar Global Positioning System (GPS)	9,110	7,206	74.8	-29.7	-2.1
Navstar Global Positioning System (GPS) Space & Control	7,602	6,217	22.3	1.7	1.0
Navstar Global Positioning System (GPS) User Equipment	1,508	989	52.5	-31.4	-3.1
Navy Multiband Terminal	1,881	2,321	-19.0	-7.6	-19.0
P-8A Poseidon	32,969	31,034	6.2	0.4	8.7
Patriot Advanced Capability-3 (PAC-3)	11,581	5,213	122.2	6.0	14.1
PATRIOT/Medium Extended Air Defense System (MEADS) Combined Aggregate Program (CAP)	11,310	26,650	-73.7	-80.2	-70.3
PATRIOT/Medium Extended Air Defense System (MEADS) Combined Aggregate Program (CAP) Fire Unit	3,373	19,363	-82.6	-82.1	-82.1
PATRIOT/Medium Extended Air Defense System (MEADS) Combined Aggregate Program (CAP) Missile	7,937	7,287	8.9	1.9	11.8
Reaper Unmanned Aircraft System (UAS)	11,892	2,637	351.0	5.2	351.0
Remote Minehunting System	1,414	1,442	-1.9	9.2	-1.9
Sea Launched Ballistic Missile - UGM 133A Trident II (D-5) Missile	53,232	51,724	2.9	2.0	4.9
Small Diameter Bomb (SDB) Increment II	4,696	4,702	-0.1	-0.1	-0.1
Space Based Infrared System (SBIRS) High Program	18,339	4,597	299.0	13.2	61.6
Space Based Space Surveillance (SBSS) Block 10	972	872	11.4	3.8	11.4
Standard Missile-6 (SM-6) Extended Range Active Missile (ERAM)	6,297	5,700	10.5	1.2	13.8
Stryker Family of Vehicles (Stryker)	18,213	8,033	126.7	11.1	47.4

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Fiscal year 2012 dollars in millions

Program	Current total acquisition cost	First full total acquisition cost	Change in total acquisition cost from first full estimate (percent)	Change in total acquisition cost within the past year (percent)	Change in total acquisition cost within the past 5 years (percent)
V-22 Joint Services Advanced Vertical Lift Aircraft (OSPREY)	57,211	40,099	42.7	0.5	5.2
Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle (VTUAV)	2,615	2,615	0.0	4.3	0.0
Virginia Class Submarine (SSN 774)	83,746	60,449	38.5	0.4	-6.0
Warfighter Information Network-Tactical (WIN-T) Increment 2	6,053	3,708	63.2	25.7	63.2
Warfighter Information Network-Tactical (WIN-T) Increment 3	13,871	16,368	-15.3	0.8	-15.3
Warfighter Information Network-Tactical (WIN-T) Increment I	4,505	4,087	10.2	10.8	10.2
Wideband Global SATCOM (WGS)	3,674	1,194	207.8	1.7	67.8

Source: GAO analysis of DOD data.

Notes: Data were obtained from DOD's Selected Acquisition Reports, acquisition program baselines, and, in some cases, program offices. Percent change in total acquisition cost for the Littoral Combat Ship program is shown as "NA" because DOD reported incomplete baseline and cost data for the program through 2010.

Appendix IV

Knowledge-Based Acquisition Practices

GAO's prior work on best product-development practices found that successful programs take steps to gather knowledge that 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 summarizes these knowledge points and associated key practices.

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
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

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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.

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.

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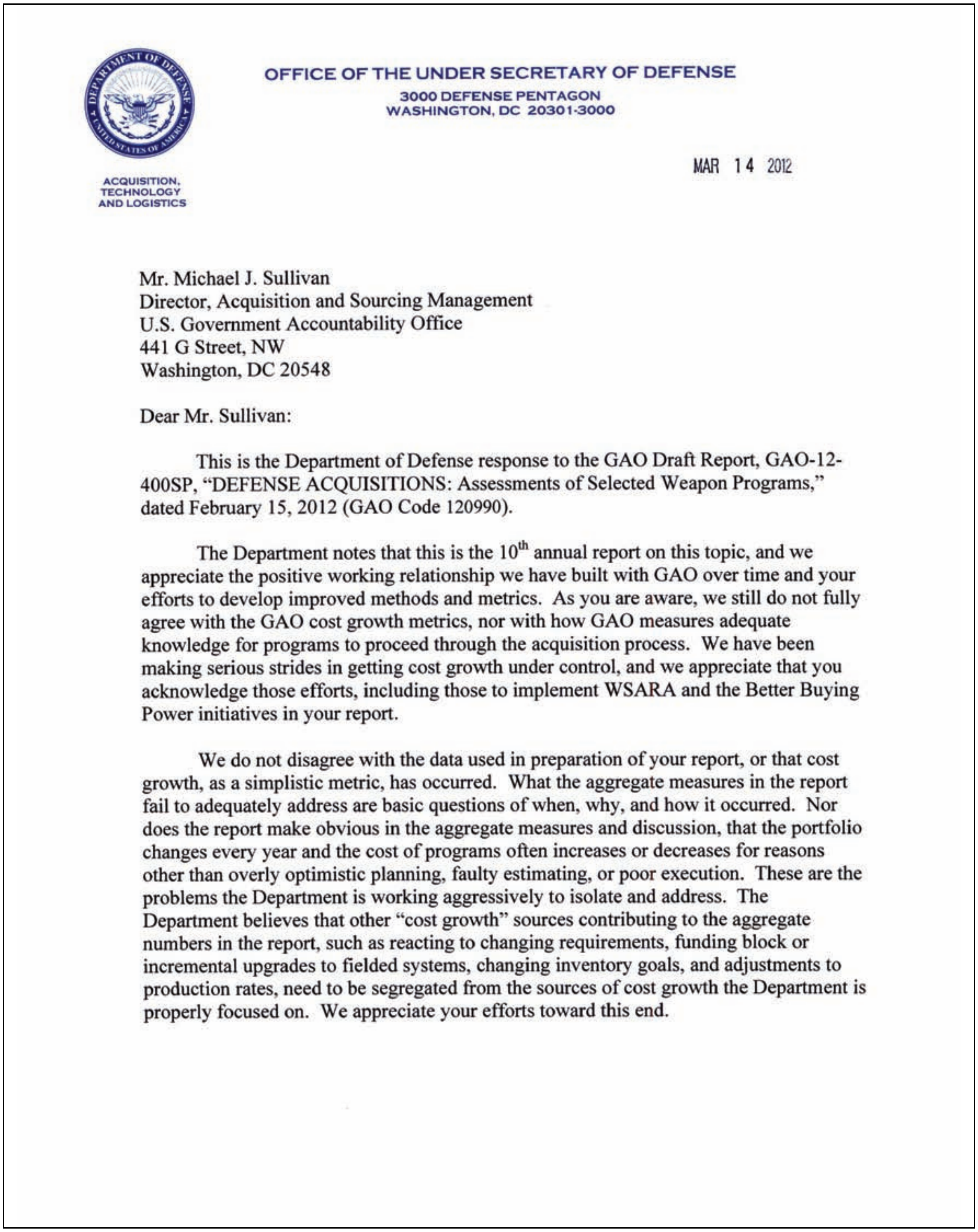
Technology Readiness Level		Description	Hardware/software	Demonstration environment
6.	System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated realistic environment.	Prototype. Should be very close to form, fit, and function. Probably includes the integration of many new components and realistic supporting elements/subsystems if needed to demonstrate full functionality of the subsystem.	High-fidelity lab demonstration or limited/restricted flight demonstration for a relevant environment. Integration of technology is well defined.
7.	System prototype demonstration in a realistic 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, a 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 (DT&E) 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 (OT&E) in operational mission conditions.

Source: GAO and its analysis of National Aeronautics and Space Administration data.

Appendix VI
Comments from the Department of Defense



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

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

MAR 14 2012

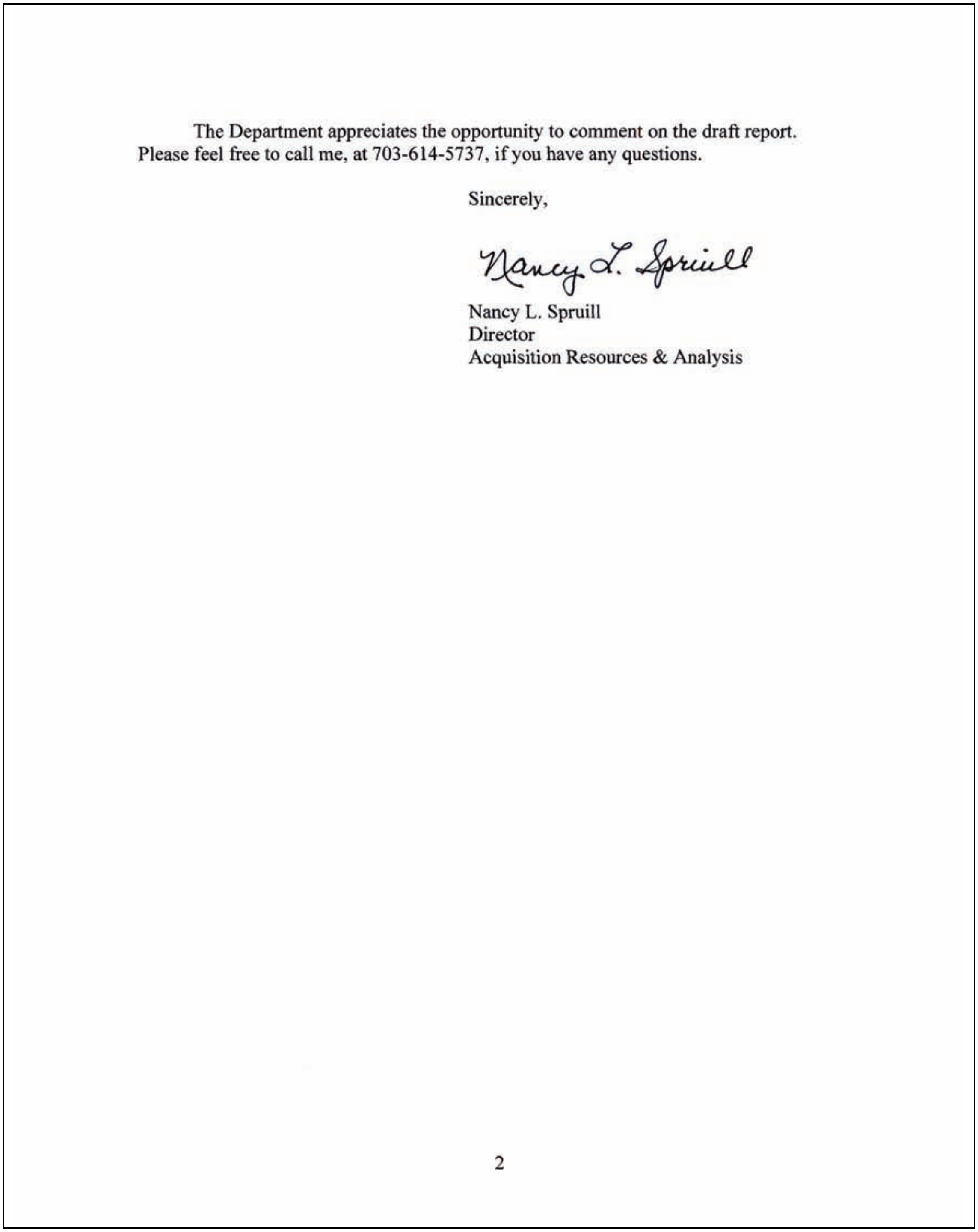
Mr. Michael J. Sullivan
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Sullivan:

This is the Department of Defense response to the GAO Draft Report, GAO-12-400SP, “DEFENSE ACQUISITIONS: Assessments of Selected Weapon Programs,” dated February 15, 2012 (GAO Code 120990).

The Department notes that this is the 10th annual report on this topic, and we appreciate the positive working relationship we have built with GAO over time and your efforts to develop improved methods and metrics. As you are aware, we still do not fully agree with the GAO cost growth metrics, nor with how GAO measures adequate knowledge for programs to proceed through the acquisition process. We have been making serious strides in getting cost growth under control, and we appreciate that you acknowledge those efforts, including those to implement WSARA and the Better Buying Power initiatives in your report.

We do not disagree with the data used in preparation of your report, or that cost growth, as a simplistic metric, has occurred. What the aggregate measures in the report fail to adequately address are basic questions of when, why, and how it occurred. Nor does the report make obvious in the aggregate measures and discussion, that the portfolio changes every year and the cost of programs often increases or decreases for reasons other than overly optimistic planning, faulty estimating, or poor execution. These are the problems the Department is working aggressively to isolate and address. The Department believes that other “cost growth” sources contributing to the aggregate numbers in the report, such as reacting to changing requirements, funding block or incremental upgrades to fielded systems, changing inventory goals, and adjustments to production rates, need to be segregated from the sources of cost growth the Department is properly focused on. We appreciate your efforts toward this end.



The Department appreciates the opportunity to comment on the draft report. Please feel free to call me, at 703-614-5737, if you have any questions.

Sincerely,

Nancy L. Spruill

Nancy L. Spruill
Director
Acquisition Resources & Analysis

GAO Contact and Acknowledgments

GAO Contact

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Acknowledgments

Principal contributors to this report were Ronald E. Schwenn, Assistant Director; J. Kristopher Keener; Deanna R. Laufer; Jenny Shinn; and Wendy P. Smythe. Other key contributors included Letisha Antone, David B. Best, Maricela Cherveny, Bruce D. Fairbairn, Arthur Gallegos, William R. Graveline, Kristine R. Hassinger, Julia M. Kennon, C. James Madar, Jean L. McSween, Diana L. Moldafsky, Kenneth E. Patton, Scott Purdy, Rae Ann H. Sapp, Roxanna T. Sun, and Bruce H. Thomas.

The following were responsible for individual programs:

System	Primary staff
Advanced Extremely High Frequency (AEHF) Satellite	Bradley L. Terry
AGM-88 Advanced Anti-Radiation Guided Missile (AARGM)	Scott Purdy, Christopher R. Durbin
Air and Missile Defense Radar (AMDR)	Ioan T. Ifrim, W. Kendal Roberts
Airborne and Maritime/Fixed Station Joint Tactical Radio System (AMF JTRS)	Paul G. Williams
Apache Block IIIA (AB3A)	Helena Brink, Andrea M. Bivens
Army Integrated Air and Missile Defense (IAMD)	Carol T. Mebane, Matt Shaffer
B-2 Defensive Management System (DMS) Modernization	Matthew P. Lea
B-2 Extremely High Frequency SATCOM Capability, Increment 1	Sean D. Merrill, Don M. Springman
B-2 Extremely High Frequency SATCOM Capability, Increment 2	Don M. Springman, Sean D. Merrill
BMDS: Aegis Ashore	Ann F. Rivlin, Luis E. Rodriguez
BMDS: Aegis Ballistic Missile Defense Standard Missile-3 Block IB	Luis Rodriguez, Ann F. Rivlin
BMDS: Aegis Ballistic Missile Defense Standard Missile-3 Block IIA	Ann F. Rivlin, Luis Rodriguez
BMDS: Aegis Ballistic Missile Defense Standard Missile-3 Block IIB	Ann F. Rivlin, Luis Rodriguez
BMDS: Ground-Based Midcourse Defense (GMD)	Steven B. Stern
BMDS: Terminal High Altitude Area Defense (THAAD)	LaTonya D. Miller
C-130 Avionics Modernization Program (AMP)	Cheryl K. Andrew, Kathy Hubbell
CH-53K - Heavy Lift Replacement (HLR)	Robert K. Miller, Marvin E. Bonner
Combat Rescue Helicopter (CRH)	Jessica A. Drucker, J. Andrew Walker
Common Infrared Countermeasures (CIRCM)	Danny G. Owens
Common Vertical Lift Support Platform (CVLSP)	Travis J. Masters, Robert K. Miller
CVN 78 Class	Robert P. Bullock, W. Kendal Roberts

(Continued From Previous Page)

System	Primary staff
DDG 1000 Destroyer	Gavin Ugale, Deanna R. Laufer
DDG 51 Destroyer	C. James Madar, G. Michael Mikota
E-2D Advanced Hawkeye (E-2D AHE)	Jeffrey L. Hartnett, Teague A. Lyons
Enhanced Polar System (EPS)	Bradley L. Terry
Excalibur Precision Guided Extended Range Artillery Projectile	Wendy P. Smythe
Expeditionary Fighting Vehicle (EFV)	MacKenzie H. Cooper, Jerry W. Clark
F-22 Modernization Increment 3.2B	Sean Seales, Marvin E. Bonner
F-35 Lightning II (Joint Strike Fighter)	LeAnna Parkey, Charlie Shivers
Family of Advanced Beyond Line-of-Sight Terminals (FAB-T)	Alexandra K. Dew
Global Hawk (RQ-4A/B)	Laura Jezewski, Rae Ann H. Sapp
Global Positioning System (GPS) III	Laura T. Holliday
GPS III OCX Ground Control Segment	Arturo Holguin, Jr.
Gray Eagle Unmanned Aircraft System	Tana M. Davis
Ground Combat Vehicle (GCV)	Marcus C. Ferguson
HC/MC-130 Recapitalization Program	Brian T. Smith, Christopher R. Durbin
Integrated Defensive Electronic Countermeasures (IDECM) Block 4	James Kim, Christopher R. Durbin
Joint Air-to-Ground Missile (JAGM)	Carrie W. Rogers, Greg Campbell
Joint Air-to-Surface Standoff Missile Extended Range (JASSM-ER)	John W. Crawford, Michael J. Hesse
Joint High Speed Vessel (JHSV)	Jenny Shinn, J. Kristopher Keener
Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS)	John M. Ortiz
Joint Light Tactical Vehicle (JLTV)	Dayna L. Foster
Joint Precision Approach and Landing System (JPALS)	Stephen V. Marchesani, Sally Williamson
Joint Tactical Radio System (JTRS) Ground Mobile Radios (GMR)	Ann Marie Udale, Guisseli Reyes-Turnell
Joint Tactical Radio System (JTRS) Handheld, Manpack, and Small Form Fit (HMS)	Nathan A. Tranquilli, David A. Garcia
KC-46 Tanker Replacement Program	Wendel K. Hudson, Mary Jo Lewnard
LHA Replacement Amphibious Assault Ship	Celina F. Davidson, Ramzi N. Nemo
Littoral Combat Ship (LCS)	Rebecca A. Wilson, Molly W. Traci
Littoral Combat Ship–Mission Modules	Laurier R. Fish, Mya Dinh, Gwyneth B. Woolwine
Mobile User Objective System (MUOS)	Richard Y. Horiuchi, Desirée E. Cunningham
MQ-4C Broad Area Maritime Surveillance (BAMS) Unmanned Aircraft System (UAS)	W. William Russell IV, Tom Twambly, Joseph Fread
Navy Multiband Terminal (NMT)	Lisa P. Gardner
Nett Warrior	William C. Allbritton
Ohio-Class Replacement (OR)	C. James Madar, G. Michael Mikota
P-8A Poseidon	Kathryn M. Edelman, Lina J. Khan

(Continued From Previous Page)

System	Primary staff
Patriot/Medium Extended Air Defense System (MEADS) Combined Aggregate Program (CAP) Fire Unit	Ryan D. Stott, Carol T. Mebane
Presidential Helicopter (VXX)	Teakoe S. Coleman, Jerry W. Clark
Reaper Unmanned Aircraft System (UAS)	Rae Ann H. Sapp, Laura Jezewski
Ship to Shore Connector (SSC)	Meghan Hardy, Molly W. Traci
Small Diameter Bomb (SDB) Increment II	Michael J. Hesse, John W. Crawford
Space Based Infrared System (SBIRS) High Program	Claire Buck
Space Fence	Peter E. Zwanzig, Maricela Cherveny
Standard Missile-6 (SM-6) Extended Range Active Missile (ERAM)	Angie Nichols-Friedman, Wiktor Niewiadomski
Three Dimensional Expeditionary Long Range Radar (3DELRR)	Claire Li, Janet McKelvey
Unmanned Carrier-Launched Airborne Surveillance and Strike System (UCLASS)	Julie C. Hadley, Travis J. Masters
Vertical Take-off and Landing Tactical Unmanned Aerial Vehicle (VTUAV)	Leigh Ann Nally, John Lack
Warfighter Information Network-Tactical (WIN-T) Increment 2	James P. Tallon, Laurier R. Fish
Warfighter Information Network-Tactical (WIN-T) Increment 3	James P. Tallon, Laurier R. Fish

Source: GAO.

Related GAO Products

Weapons Acquisition Reform: Actions Needed to Address Systems Engineering and Developmental Testing Challenges. GAO-11-806. Washington, D.C.: September 19, 2011.

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

Defense Acquisitions: Assessments of Selected Weapon Programs. GAO-11-233SP. Washington, D.C.: March 29, 2011.

Defense Acquisitions: Observations on Weapon Program Performance and Acquisition Reforms. GAO-10-706T. Washington, D.C: May 19, 2010.

Defense Acquisitions: Strong Leadership Is Key to Planning and Executing Stable Weapon Programs. GAO-10-522. Washington, D.C.: May 6, 2010.

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

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

Defense Acquisitions: Charting a Course for Lasting Reform. GAO-09-663T. Washington, D.C.: April 30, 2009.

Defense Acquisitions: Measuring the Value of DOD's Weapon Programs Requires Starting with Realistic Baselines. GAO-09-543T. Washington, D.C.: April 1, 2009.

Defense Acquisitions: DOD Must Balance Its Needs with Available Resources and Follow an Incremental Approach to Acquiring Weapon Systems. GAO-09-431T. Washington, D.C.: March 3, 2009.

GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs. GAO-09-3SP. Washington, D.C.: March 2, 2009.

Defense Acquisitions: Perspectives on Potential Changes to Department of Defense Acquisition Management Framework. GAO-09-295R. Washington, D.C.: February 27, 2009.

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

Best Practices: Increased Focus on Requirements and Oversight Needed to Improve DOD's Acquisition Environment and Weapon System Quality. GAO-08-294. Washington, D.C.: February 1, 2008.

Best Practices: An Integrated Portfolio Management Approach to Weapon System Investments Could Improve DOD's Acquisition Outcomes. GAO-07-388. Washington, D.C.: March 30, 2007.

Defense Acquisitions: Major Weapon Systems Continue to Experience Cost and Schedule Problems under DOD's Revised Policy. GAO-06-368. Washington, D.C.: April 14, 2006.

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

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

Best Practices: A More Constructive Test Approach Is Key to Better Weapon System Outcomes. GAO/NSIAD-00-199. Washington, D.C.: July 31, 2000.

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

Best Practices: Successful Application to Weapon Acquisition Requires Changes in DOD's Environment. GAO/NSIAD-98-56. Washington, D.C.: February 24, 1998.

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