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GAO

Report to Congressional Committees

March 2006

DEFENSE ACQUISITIONS

Assessments of Selected Major Weapon Programs

The Web version of this report was reposted on April 3, 2006, to reflect a change to the text on page 1 since the original version was posted on March 31, 2006. A typographical error was identified wherein the report states "In the past 5 years, DOD has doubled its planned investments in new weapon systems from $700 million to $1.4 trillion." The report should have stated $700 billion instead of $700 million.

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GAO-06-391

March 2006

DEFENSE ACQUISITIONS

Assessments of Selected Major Weapon Programs

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Highlights

Highlights of GAO-06-391, a report to congressional commitees

Why GAO Did This Study

In the last 5 years, the Department of Defense (DOD) has doubled its planned investments in new weapon systems from about $700 billion in 2001 to nearly $1.4 trillion in 2006. While the weapons that DOD develops have no rival in superiority, weapon systems acquisition remains a long-standing high risk area. GAO's reviews over the past 30 years have found consistent problems with weapon acquisitions such as cost increases, schedule delays, and performance shortfalls. In addition, DOD faces several budgetary challenges that underscore the need to deliver its new weapon programs within estimated costs and to obtain the most from these investments.

This report provides congressional and DOD decision makers with an independent, knowledge-based assessment of selected defense programs that identifies potential risks and needed actions when a program's projected attainment of knowledge diverges from the best practices. Programs for the assessments were selected based on several factors including, (1) high dollar value, (2) stage in acquisition, and (3) congressional interest. The majority of the 52 programs covered in this report are considered major defense acquisition programs by DOD. This report also highlights higher level issues raised by the cumulative experiences of individual programs. GAO updates this report annually under the Comptroller General's authority.

www.gao.gov/cgi-bin/getrpt?GAO-06-391.

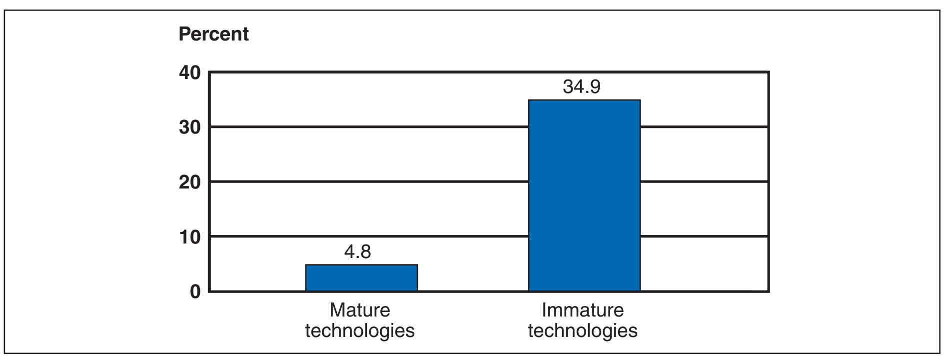
To view the full product, including the scope and methodology, click on the link above. For more information, contact Paul L. Francis at (202) 512-4841 or FrancisP@gao.gov.

What GAO Found

GAO assessed 52 systems that represent an investment of over $850 billion, ranging from the Missile Defense Agency's Airborne Laser to the Army's Warfighter Information Network-Tactical. DOD often exceeds development cost estimates by approximately 30 to 40 percent and experiences cuts in planned quantities, missed deadlines, and performance shortfalls. Such difficulties, absent definitive and effective reform outcomes, are likely to cause great turmoil in a budget environment in which there are growing fiscal imbalances as well as increasing conflict over increasingly limited resources. While these problems are in themselves complex, they are heightened by the fact that this current level of investment is by no means final and unchangeable. A large number of the technologies under development in these systems are sufficiently new and immature that it is uncertain how long it will take or how much it will cost to make them operational.

Most of the 52 programs GAO reviewed have proceeded with lower levels of knowledge than suggested by best practices. Programs that start with mature technologies do better. As shown in the figure below, programs that began with immature technologies have experienced average research and development cost growth of 34.9 percent; programs that began with mature technologies have only experienced cost growth of 4.8 percent.

Average Program Research, Development, Test, and Evaluation Cost Growth from First Full Estimate



Source: GAO analysis.

If DOD continues to move programs through development without requisite technology, design, and production knowledge, costs and schedules will increase, which will reduce the quantity delivered to the warfighter. This practice will also continue to reduce DOD's buying power, as less capability will be provided for the money invested. In the larger context, DOD needs to make changes in its requirements and budgeting processes that are consistent with getting the desired outcomes from the acquisition process.

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Abbreviations

AMRDEC	Aviation and Missile Research Development and Engineering Center
ARS	analysis and reporting system
ATACMS BAT	Army Tactical Missile System Brilliant Antiarmor Submunition
BAMS	Broad Area Maritime Surveillance
CDA	Commander's Digital Assistant
CEC	Cooperative Engagement Capability
CMUP	Conventional Mission Upgrade Program
DARPA	Defense Advanced Research Projects Agency
DBCS	Dismounted Battle Command System
DOD	Department of Defense
EKV	exoatmospheric kill vehicle
EPLRS	Enhanced Position Location Reporting System
FY	fiscal year
GAO	Government Accountability Office
GEO	geosynchronous earth orbit
GMLRS	Guided Multiple Launch Rocket System
HEO	highly elliptical orbit
ICD	Interface Control Design
ISR	intelligence, surveillance, and reconnaissance
JASSM	Joint Air-to-Surface Standoff Missile
JDAM	Joint Direct Attack Munition
JLENS	Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System
JPATS	Joint Primary Aircraft Training System
JSOW	Joint Standoff Weapon
MCS	Maneuver Control System
MDA	Missile Defense Agency
MDAP	Major Defense Acquisition Program
MEADS	Medium Extended Air Defense System
MIDS-LVT	Multifunctional Information Distribution System - Low Volume Terminal
MM III GRP	Minuteman III Guidance Replacement Program
NA	not applicable
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
OCS	Operational Control System
OSD	Office of the Secretary of Defense

PTIR	precision track illumination radar
RDT&E	Research, Development, Test and Evaluation
SAR	Selected Acquisition Report
SDACS	Solid Divert and Attitude Control System
SDR	Systems Design Review
SOCOM	Special Operations Command
SPC	statistical process control
SUR	surveillance radar
TBD	to be determined
TBIP	Tomahawk Baseline Improvement Program
TRL	Technology Readiness Level
UAV	Unmanned Aerial Vehicle
UHF	ultra high frequency
U.S.C.	United States Code

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March 31, 2006

Congressional Committees

Current and expected fiscal imbalances demand that the Department of Defense (DOD) maximize its return on investment and provide the warfighter with needed capabilities at the best value for the taxpayer. Since 1990, we have assessed weapon acquisitions as a high-risk area. Not only does it continue to be a high risk area, but it has also taken on heightened importance. To transform military operations, DOD has embarked on developing multiple megasystems that are expected to be the most expensive and complex ever. However, these costly acquisitions are running head-on into the nation's unsustainable fiscal path. In the past 5 years, DOD has doubled its planned investments in new weapon systems from $700 billion to $1.4 trillion. This huge increase has not been accompanied by more stability, better outcomes, or more buying power for the acquisition dollar.

This is our fourth annual assessment of weapon programs. It contains our assessment of 52 weapon programs representing a projected investment of about $850 billion. Unfortunately, our assessments do not show appreciable improvement in the acquisition of major weapon systems. Rather, programs are experiencing recurring problems with cost overruns, missed deadlines, and performance shortfalls. These cost increases mean that DOD cannot produce as many weapons as intended nor deliver those weapons to the warfighter when promised. These problems occur, in part, because weapon programs do not capture the requisite knowledge when needed to efficiently and effectively manage program risks. Programs consistently move forward with unrealistic cost and schedule estimates, use immature technologies in launching product development, and fail to solidify design and manufacturing processes at appropriate points in development.

The past year has seen several major defense reviews that lay down approaches to improve the way DOD buys weapons. These reviews contain many constructive ideas. If they are to produce better results, however, they must heed the lessons taught—but perhaps not learned—of acquisition history. Specifically, policy must be manifested in decisions on individual programs or reform will be blunted. DOD's current acquisition policy is a case in point. The policy supports a knowledge-based, evolutionary approach to acquiring new weapons. The practice—decisions made on individual programs—sacrifices knowledge and executability in favor of revolutionary solutions. It's time to challenge such solutions. Reform will not be real unless each weapon system is shown to be both a worthwhile investment and an executable program. Otherwise, we will continue to start more programs than we can finish, produce less capability for more money, and create the next set of case studies for future defense reform reviews.

David M. Walker
Comptroller General
of the United States

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

March 31, 2006

Congressional Committees

One of the single largest investments the federal government makes is the development and production of new weapon systems. In the last 5 years, the Department of Defense (DOD) has doubled its planned investments in new weapon systems from about $700 billion in 2001 to nearly $1.4 trillion in 2006. It is imperative that these investments deliver as promised not only because of their value to the warfighter but because every dollar spent on weapon systems means one dollar less of something else DOD or the Government can do. There is ample basis for serious concerns on this score. The cost of developing a weapon system continues to often exceed estimates by approximately 30 percent to 40 percent. This in turn results in fewer quantities, missed deadlines, and performance shortfalls. In short, the buying power of the weapon system investment dollar is reduced; the warfighter gets less than promised; and opportunities to make other investments are lost. This is not to say that the nation does not get superior weapons in the end, but that at twice the level of investment, DOD has an obligation to get better results. In the larger context, DOD needs to make changes in its requirements and budgeting processes that are consistent with getting the desired outcomes from the acquisition process.

Given growing fiscal imbalances as well as competition for increasingly scarce resources, this current level of investment is by no means final and unchangeable. To get better results, programs need to have higher levels of knowledge when they start, which enable better estimates of how much they will cost to finish. Currently, a large number of the technologies under development in major systems are sufficiently new and immature that it is uncertain how long it will take or how much it will cost to make them operational. Predictably, developing these systems without sufficient knowledge will take longer and cost even more than promised and deliver fewer quantities and other capabilities than planned. Over the years, we have made a number of recommendations to address these issues, both systemically and on individual programs.

In this report, we assess 52 programs that represent an investment of approximately $858 billion.[1] Our objective is twofold: to provide decision makers with a cross-cutting analysis of DOD weapons system investment and also to provide independent, knowledge-based assessments of individual systems' attained knowledge and potential risks.

Programs were selected for individual assessment based on several factors including, (1) high dollar value, (2) stage in acquisition, and (3) congressional interest. The majority of the 52 programs covered in this report are considered major defense acquisition programs by DOD.

Fiscal Challenges Confronting DOD Necessitate Better Acquisition Outcomes

DOD's investment in the research, development, test, and evaluation (RDT&E) and procurement of major weapon systems is expected to rise from $147 billion in fiscal year 2006 to $178 billion in fiscal year 2011.[2] DOD's total planned investment in Major Defense Acquisition Programs is nearly $1.4 trillion (2006 dollars) for its current portfolio, with over $840 billion of that investment yet to be made.[3]

Budget simulations by GAO, the Congressional Budget Office, and others show that, over the long term, we face a large and growing structural deficit due primarily to known demographic trends and rising health care costs. As the Comptroller General has noted, continuing on this unsustainable fiscal path will gradually erode, if not suddenly damage, our economy, our standard of living, and ultimately our national security. Federal discretionary spending, along with other federal policies and programs, will face serious budget pressures in the coming years stemming from new budgetary demands and demographic trends. Defense spending falls within the discretionary spending accounts. Further, current military operations, such as those in Afghanistan and Iraq, consume a large share of DOD budgets and are causing faster wear on existing weapons. Refurbishment or replacement sooner than planned is putting further pressure on DOD's investment accounts.

At the same time DOD is facing these problems, programs are commanding larger budgets. DOD is undertaking new efforts that are expected to be the

[1] This estimate includes total RDT&E; procurement; military construction; and acquisition operation and maintenance appropriations to develop the weapon systems. The macro analyses contained in this report are based on data as of January 15, 2006, and may not reflect subsequent events. For example, the Joint Tactical Radio System programs are currently being restructured.

[2] Estimates in then-year dollars as reported in the Fiscal Year 2006 Department of Defense Future Years Defense Program Table 1-1 for RDT&E and Procurement.

[3] This estimate is for Major Defense Acquisition Programs (MDAPs). MDAPs are programs identified by DOD as programs that require eventual RDT&E expenditures of more than $365 million or $2.19 billion in procurement in fiscal year 2000 constant dollars.

most expensive and complex ever and on which DOD is heavily relying to fundamentally transform military operations. Table 1 shows that just 5 years ago, the top five weapon systems were projected to cost about $291 billion combined; today, the top five weapon systems are projected to cost about $550 billion.

Table 1: Total Projected Cost of DOD's Top Five Programs in Fiscal Years 2001 and 2006

Billions of constant 2006 dollars

2001		2006	
Program	**Cost**	**Program**	**Cost**
F-22A Raptor aircraft	$65.0	Joint Strike Fighter aircraft	$206.3
DDG-51 class destroyer ship	$64.4	Future Combat Systems	$127.5
Virginia class submarine	$62.1	Virginia class submarine	$80.4
C-17 Globemaster airlift aircraft	$51.1	DDG-51 class destroyer ship	$70.4
F/A-18E/F Super Hornet fighter aircraft	$48.2	F-22A Raptor aircraft	$65.4
Total	**$290.8**	**Total**	**$550.0**

Source: GAO analysis of DOD data.

The larger scope of development associated with these megasystems produces a much larger fiscal impact when cost and schedule estimates increase. The top 5 programs in 2001 and the top 5 programs in 2006 have both experienced about a 40 percent increase in projected RDT&E costs from the first full estimate to the latest estimate. In the same base-year dollars, the total fiscal impact was much greater for the 2006 top 5 programs, however, as RDT&E costs increased by $33.9 billion as opposed to $16.9 billion for the top 5 from 2001 because of the larger scope of development planned for the 2006 top 5 programs. The Joint Strike Fighter and Future Combat Systems contribute significantly to this projected cost growth, as their combined cost is greater than all of the top 5 programs in 2001.

DOD's Weapon Programs Portfolio Often Experiences a Reduced Return on Investment

The way DOD develops and produces its major weapon systems has had disappointing consequences. A large number of the programs in our assessment are costing more and taking longer to develop than estimated. As shown in table 2, total RDT&E costs for 26 common set[4] weapon programs increased by nearly $44.6 billion, or 37 percent, over the original business case (the first full estimate). The same programs have also experienced an increase in the time needed to develop capabilities with a weighted-average schedule increase of nearly 17 percent.[5]

Table 2: Cost and Cycle Time Growth for 26 Weapon Systems

Billions of constant 2006 dollars

	First full estimate	Latest estimate	Percentage change
Total cost	$547.7	$627.4	14.6
RDT&E cost	$120.4	$164.9	37.0
Weighted average acquisition cycle time[a]	154.5 months	180.2 months	16.7

Source: GAO analysis of DOD data.

[a]This is a weighted estimate of average acquisition cycle time for the 26 programs based on total program costs at the first full and latest estimates. The simple average for these two estimates was 112.1 months for the first full estimate and 131.3 months for the latest estimate resulting in a 17.2 percent change.

[4] The common set refers to the 26 programs that we were able to assess since development began. The 26 programs are ACS, AEHF, AESA, APKWS, B-2 RMP, C-5 AMP, C-5 RERP, CH-47F, CVN-21, E-2D AHE, EFV, Excalibur, F-22A, FCS, Global Hawk, JSF, JTRS Cluster 5, Land Warrior, MMA, MUOS, NPOESS, Patriot/MEADS CAP, Predator B, SDB, V-22, and WGS. We limited this analysis to these 26 programs because all data including cost, schedule, and quantities were available for comparison between program estimates. The data in table 2 does not represent the same common set of 26 programs reported in the 2005 assessment. GAO, *Defense Acquisitions: Assessments of Selected Major Weapon Programs*, GAO-05-301 (Washington, D.C.: Mar. 31, 2005).

[5] A weighted average gives more expensive programs a greater value.

Quantities for 9 of the common set programs have been reduced since their first estimate.[6] In addition, the weighted-average program acquisition unit cost for 25 of the 26 programs increased by roughly 57 percent.[7]

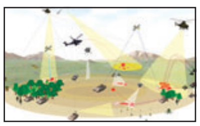
The consequence of cost and cycle-time growth is manifested in a reduction of the buying power of the defense dollar. Table 3 illustrates six programs included in this assessment with a significant reduction in buying power; we have reported similar outcomes in many more programs. For example, the Air Force initially planned to buy five Spaced Based Infrared System High satellites at a program acquisition unit cost of about $816 million (fiscal year 2006 dollars). Technology and design components matured late in the development of the satellite, which contributed to cost growth and four Nunn-McCurdy[8] unit cost breaches. Now, the Air Force plans to buy 3 satellites at a program acquisition unit cost of about $3.4 billion, a 315 percent increase.

[6] The 9 programs are AEHF, Excalibur, APKWS, V-22, JSF, C-5 RERP, F-22A, Global Hawk, and C-5 AMP.

[7] This estimate is a weighted average based on total program cost and does not include the Excalibur program because of its extreme unit cost growth. The simple average program unit cost increase for the same 25 programs is 36 percent. The weighted average, including the Excalibur, is 62 percent.

[8] 10 U.S.C § 2433. Requires DOD to (1) notify Congress whenever unit cost growth is at least 15 percent, and (2) "certify" the program to Congress when unit cost growth is at least 25 percent above the latest approved acquisition baseline cost estimate.

Table 3: Examples of DOD Programs with Reduced Buying Power

Program		Initial estimate	Initial quantity	Latest estimate	Latest quantity	Percent of unit cost increase
Joint Strike Fighter		$189. 8 billion	2,866 aircraft	$206.3 billion	2,458 aircraft	26.7
Future Combat Systems		$82.6 billion	15 systems	$127.5 billion	15 systems	54.4
F-22A Raptor		$81.1 billion	648 aircraft	$65.4 billion	181 aircraft	188.7
Evolved Expendable Launch Vehicle		$15.4 billion	181 vehicles	$28.0 billion	138 vehicles	137.8
Space Based Infrared System High		$4.1 billion	5 satellites	$10.2 billion	3 satellites	315.4
Expeditionary Fighting Vehicle		$8.1 billion	1,025 vehicles	$11.1 billion	1,025 vehicles	35.9

Source: GAO analysis of DOD data. Images sourced in their respecitve order: JSF Program Office; Program Manager, Unit of Action, U.S. Army; F-22A System Program Office; (Left) © 2003 ILS/Lockheed Martin, (right) © 2003 The Boeing Company; Lockheed Martin Space Systems Company; General Dynamics Land Systems.

A Knowledge-Based Approach Can Lead to Better Acquisition Outcomes

Over the last several years, we have undertaken a body of work that examines weapon acquisition issues from a perspective that draws upon lessons learned from best product development practices. Leading commercial firms expect that their program managers will deliver high-quality products on time and within budget. Doing otherwise could result in the customer walking away. Thus, those firms have created an environment and adopted practices that put their program managers in a good position to succeed in meeting these expectations. Collectively, these practices comprise a process that is anchored in knowledge. It is a process in which technology development and product development are treated differently and managed separately. The process of developing technology culminates in discovery—the gathering of knowledge—and must, by its nature, allow room for unexpected results and delays. Leading firms do not ask their product managers to develop technology. Successful programs give responsibility for maturing technologies to science and technology organizations, rather than the program or product development managers. The process of developing a product culminates in delivery and, therefore, gives great weight to design and production. The firms demand—and receive—specific knowledge about a new product before production begins. A program does not go forward unless a strong business case on which the program was originally justified continues to hold true.

Successful product developers ensure a high level of knowledge is achieved at key junctures in development. We characterize these junctures as knowledge points. These knowledge points and associated indicators are defined as follows:

- **Knowledge point 1**: Resources and needs match. This point occurs when a sound business case is made for the product—that is, a match is made between the customer's requirements and the product developer's available resources in terms of knowledge, time, money, and capacity. Achieving a high level of technology maturity at the start of system development is an important indicator 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.

- **Knowledge point 2**: Product design is stable. This point occurs when a program determines that a product's design is stable—that is, it 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 development. Completion of at least 90 percent of engineering drawings at the system design review provides tangible evidence that the design is stable.

- **Knowledge point 3**: Production processes are mature and the design is reliable. This point is achieved when it has been demonstrated that the company can manufacture the product within cost, schedule, and quality targets. A best practice is to ensure that all key 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.

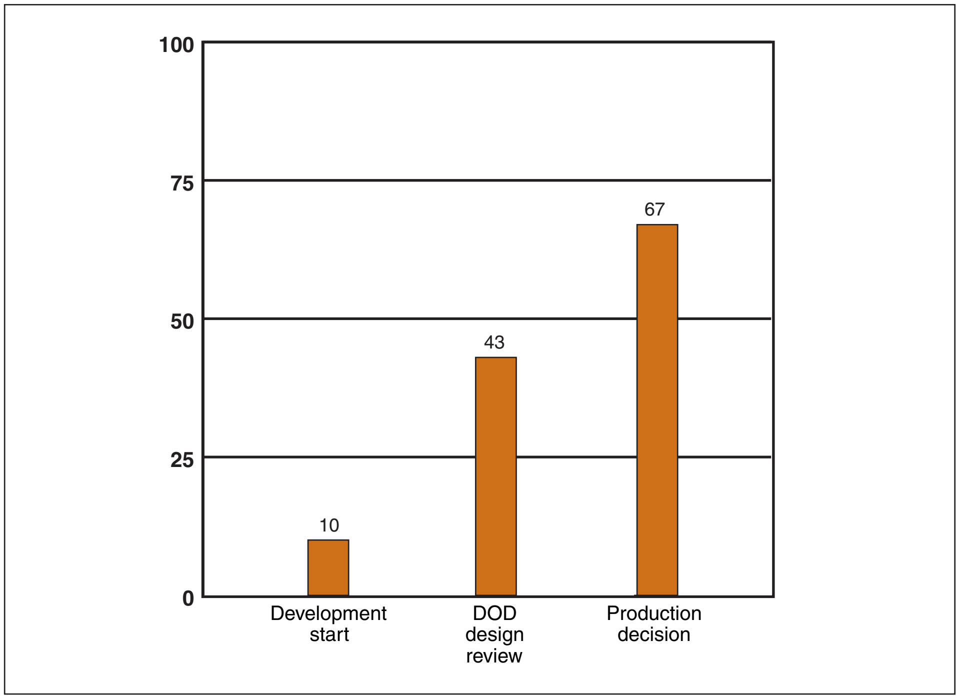
A result of this knowledge-based process is evolutionary product development, an incremental approach that enables developers to rely more on available resources rather than making promises about unproven technologies. Predictability is a key to success as successful product developers know that invention cannot be scheduled, and its cost is difficult to estimate. They do not bring a technology into new product development unless that technology has been demonstrated to meet the user's requirements. Allowing technology development to spill over into product development puts an extra burden on decision makers and provides a weak foundation for making product development estimates. While the user may not initially receive the ultimate capability under this approach, the initial product is available sooner and at a lower, more predictable cost.

There is a synergy in this process, as the attainment of each successive knowledge point builds on the preceding one. Metrics gauge when the requisite level of knowledge has been attained. Controls are used to ensure a high level of knowledge is attained before making additional significant investments. Controls are considered effective if they are backed by measurable criteria and if decision makers are required to consider them before deciding to advance a program to the next level. Effective controls help decision makers gauge progress in meeting cost, schedule, and performance goals and ensure that managers will (1) conduct activities to capture relevant product development knowledge, (2) provide evidence that knowledge was captured, and (3) hold decision reviews to determine that appropriate knowledge was captured to move to the next phase. The result is a product development process that holds decision makers accountable and delivers excellent results in a predictable manner.

Most Programs Proceed with Lower Levels of Knowledge at Critical Junctures

To get the most out of its weapon systems investments, DOD revised its acquisition policy in May 2003 to incorporate a knowledge-based, evolutionary framework. The policy requires decision makers to have the knowledge they need before moving to the next phase of development. However, most of the programs we reviewed proceeded with lower levels of knowledge at critical junctures and attained key elements of product knowledge later in development than specified in DOD policy. Once a program gets behind in demonstrated knowledge, it stays behind (see fig. 1).

Figure 1: Percent of Programs That Achieved Technology Maturity at Key Junctures



Source: GAO analysis of DOD data.

Only 10 percent of the programs in our assessment demonstrated all of their critical technologies as mature at the start of development, meaning they fell far short of attaining knowledge point 1 when they should have. By the time of their design review—when they should have demonstrated knowledge point 2 (stable design)—only 43 percent had actually attained knowledge point 1 (all critical technologies mature). By the time of the decision to start production when the programs should have demonstrated knowledge point 3 (production processes in control) one third still had not attained knowledge point 1. Similarly, only 35 percent of the programs in our assessment believed they had attained knowledge point 2 at the design review and only 58 percent believed they had attained knowledge point 2 by the time of the decision to start production. None of the programs we assessed that are now in production reported using statistical process control data to measure the maturity of production processes. This is the data needed to demonstrate knowledge point 3. In other words, none of the programs demonstrated knowledge point 3. This suggests that programs that follow the policy are the exception; the predominant practice is to still proceed with knowledge gaps.

Consequences accrue to programs that are still working to mature technologies well into system development when they should be focused on maturing system design and preparing for production. These consequences involve increased risk of cost growth and schedule delays throughout the life of the program. The cost effect of proceeding without the necessary knowledge can be dramatic. For example, RDT&E costs for the programs that started development with mature technologies increased by a modest average of 4.8 percent over the first full estimate, whereas the RDT&E costs for the programs that started development with immature technologies increased by a much higher average of 34.9 percent over the first full estimate. Likewise, program acquisition unit costs for the programs with mature technology increased by less than 1 percent, whereas the programs that started development with immature technologies experienced an average program acquisition unit cost increase of nearly 27 percent over the first full estimate.[9]

In commenting on a draft of this report, DOD stated that it is the department's policy that technologies should be demonstrated in at least a relevant environment before a program enters system development; whereas, GAO utilizes the best practice standard that calls for technologies to be assessed one step higher—demonstration in an operational environment. If we applied the DOD's lower standard, the number of programs with mature technologies at program start would have increased to 23 percent, compared with 10 percent using the best practices standard. This is a higher number but does not alter the fact that most programs begin development without mature technology. A cost consequence for using the lower standard does occur, however. While the RDT&E cost growth for programs that started development with immature technologies (using the DOD standard) was about the same at 34.6 percent, the cost growth for the programs that met DOD's maturity standard was significantly greater at 18.8 percent than the 4.8 percent experienced by those that met the higher best practice standard.

[9] These percentages are program cost weighted averages. The simple average increase for program acquisition unit costs is 2.8 percent for the programs that started development with mature technologies and 19.8 percent for the programs that started development with immature technologies.

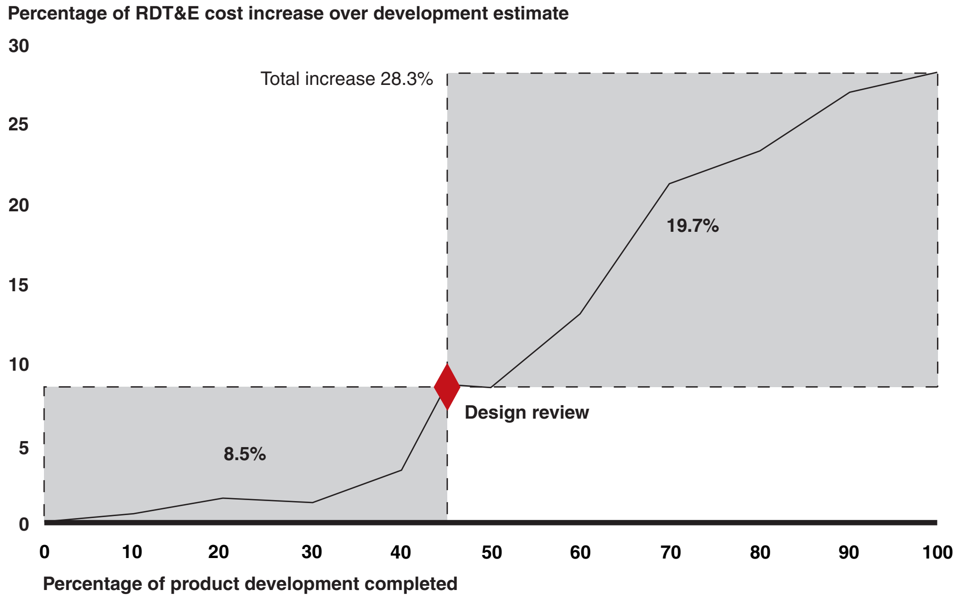
The order of how knowledge is built throughout product development is important to delivering products on time and within cost. Knowledge gaps have a cumulative effect. For example, design stability cannot be attained if key technologies are not mature. The lack of technical maturity weakens the knowledge available at the design review. The majority of programs in our assessment that have held a design review did so without first maturing critical technologies. Twenty of the 52 programs we assessed are currently scheduled to hold their critical design reviews by the year 2011. Only 2 of those 20 programs currently expect to have their technologies fully mature by the time of their design reviews, and only 4 of those 20 programs currently expect to have at least 90 percent design stability by the time of their critical design reviews.

Historically, Most Cost Growth Is Reported after the Critical Design Review

We reviewed the development cost experience of 29 programs that have completed their product development cycle--the time between the start of development and production.[10] We found a significant portion of the recognized total development cost increases of these programs took place after they were approximately half way into their product development cycle. These increases typically occurred after the time of the design review of the programs. As shown in figure 2, the programs experienced a cumulative increase in development costs of 28.3 percent throughout their product development. Approximately 8.5 percent of the total development cost growth occurred up until the time of the average critical design review. The remaining 19.7 percent occurred after the average critical design review.

[10] The 29 programs include: ATIRCM/CMWS, AEHF, AESA Radar, AIM-9X/Air to Air Missile, ATACMS BAT, B-1B CMUP, Bradley Fighting Vehicle A3 Upgrade, CH-47F, CEC, EELV, F/A-18E/F, F-22A, GMLRS Tactical Rocket, JASSM, JDAM, JPATS, JSOW, Longbow Hellfire, M1A2 Abrams, MCS, MM III GRP, MIDS-LVT, NAS, SDB, Strategic Sealift, Stryker Family of Vehicles, Tactical Tomahawk, Tomahawk TBIP, and V-22. The average design review is based on 21 of the 29 programs that either reported a critical design review date in the annual Selected Acquisition Reports or was provided to us by program officials.

Figure 2: RDT&E Percentage Increase throughout the Product Development Cycle for 29 Programs Completed or in Production



Source: GAO analysis of DOD data.

This historical pattern underscores the challenges DOD faces in executing programs currently in development. Table 4 lists the programs in our assessment that have yet to hold their critical design review.[11]

[11] Data as of January 15, 2006.

Table 4: Programs in Our Assessment Yet to Hold a Critical Design Review

Aerial Common Sensor
Advanced Deployable System
Advanced Precision Kill Weapon System
C-130 Avionics Modernization Program
Future Aircraft Carrier CVN-21
Future Combat Systems
Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System
F-35 Joint Strike Fighter
Joint Tactical Radio System Cluster 5
Patroit/Medium Extended Air Defense System Combined Aggregated Program
Multi-mission Maritime Aircraft
Mobile User Objective System
National Polar—Orbiting Operational Environmental Satellite System
MQ-9 Predator B
Warrior UAV
Warfighter Information Network - Tactical

Source: GAO analysis of DOD data.

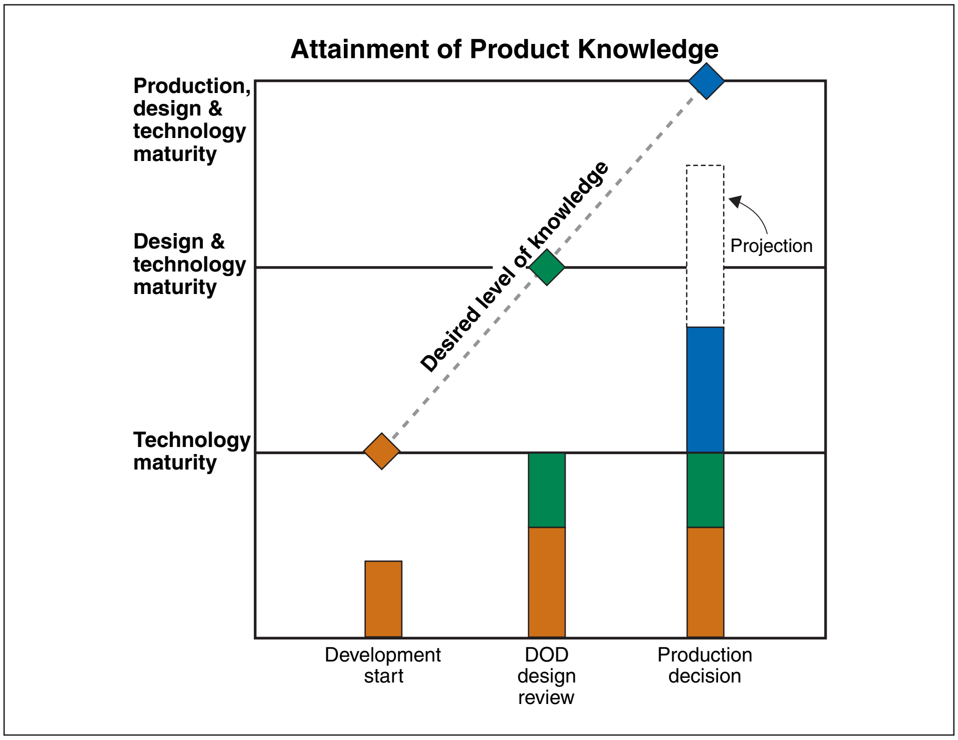
Note: List includes only those programs that have started development. Four additional programs in our assessment have scheduled their critical design review but have not yet started development.

The current planned total RDT&E investment of these 16 programs is approximately $142 billion with a total planned investment of over $521 billion. While most of these programs have yet to experience any significant cost increases, some have already experienced double digit cost increases prior to their design review. Furthermore, all 16 programs listed began development with immature technologies—10 currently still have over half of their critical technologies immature. For these programs, the markers for risk are present—historical experience and technology immaturity—as are the cost, schedule, and quantity consequences that attend that risk. If past is prologue, the decisions to continue to move programs through development without the requisite knowledge will continue to result in programs that are not delivered on time nor with the quantities and capabilities promised. These consequences are exacerbated in an environment of constrained resources as trade-offs become necessary not only within these programs, but across the entire weapons portfolio—resulting in a reduction of the department's buying power.

How to Read the Knowledge Graphic for Each Program Assessed

We assess each program in two pages and depict the extent of knowledge in a stacked bar graph and provide a narrative summary at the bottom of the first page. As illustrated in figure 3, the knowledge graph is based on the three knowledge points and the key indicators for the attainment of knowledge: technology maturity (depicted in orange), design stability (depicted in green), and production maturity (depicted in blue). A "best practice" line is drawn based on the ideal attainment of the three types of knowledge at the three knowledge points. The closer a program's attained knowledge is to the best practice line, the more likely the weapon will be delivered within estimated cost and schedule. A knowledge deficit at the start of development—indicated by a gap between the technology knowledge attained and the best practice line—means the program proceeded with immature technologies and faces a greater likelihood of cost and schedule increases as technology risks are discovered and resolved.

Figure 3: Depiction of a Notional Weapon System's Knowledge as Compared with Best Practices



Source: GAO.

An interpretation of this notional example would be that the system development began with key technologies immature, thereby missing knowledge point 1. Knowledge point 2 was not attained at the design review as some technologies were still not mature and only a small percentage of engineering drawings had been released. Projections for the production decision show that the program is expected to achieve greater levels of maturity but will still fall short. It is likely that this program would have had significant cost and schedule increases.

We conducted our review from June 2005 through March 2006 in accordance with generally accepted government auditing standards. Appendix II contains detailed information on our methodology.

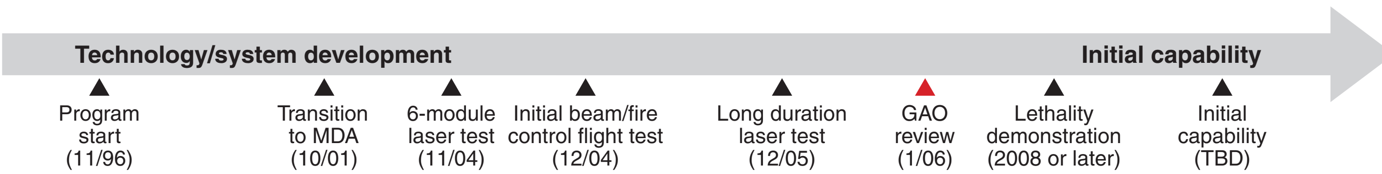
Assessments of Individual Programs

Our assessments of the 52 weapon systems follow.

Airborne Laser (ABL)

MDA's ABL element is being developed in incremental, capability-based blocks to destroy enemy missiles during the boost phase of their flight. Carried aboard a highly modified Boeing 747 aircraft, ABL employs a beam control/fire control subsystem to focus the beam on a target, a high-energy chemical laser to rupture the fuel tanks of enemy missiles, and a battle management subsystem to plan and execute engagements. We assessed the Block 2004 design that is under development and expected to lead to an initial capability in a future block.

Source: Airborne Laser Program Office.



Program Essentials

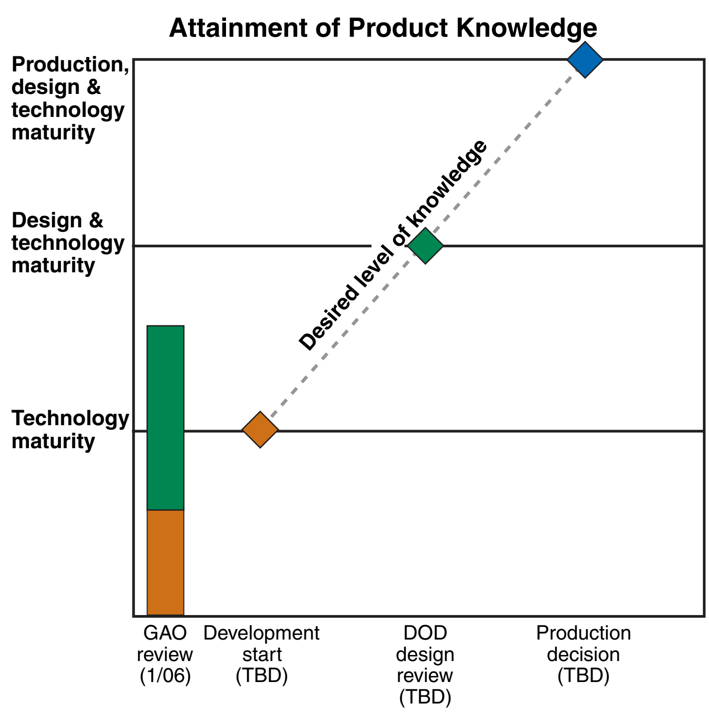
Prime contractor: Boeing
Program office: Kirtland AFB, N. Mex.
Funding, FY06-FY11:
R&D: $4,064.1 million
Procurement: $0.0 million
Total funding: $4,064.1 million
Procurement quantity: NA

Program Performance (fiscal year 2006 dollars in millions)

	As of 09/2003	Latest 07/2005	Percent change
Research and development cost	$5,626.1	$5,639.4	0.2
Procurement cost	$0.0	$0.0	0.0
Total program cost	$5,626.1	$5,639.4	0.2
Program unit cost	NA	TBD	NA
Total quantities	NA	NA	NA
Acquisition cycle time (months)	NA	TBD	NA

Latest costs include all costs from the program's inception through fiscal year 2009. Total known cost through fiscal year 2011 is $7,416.2 million.

Although program officials expected ABL to provide an initial capability during Block 2006, this event has been delayed and only one of its seven critical technologies is fully mature. During Block 2004, the program continues work on a prototype expected to provide the basic design for a future operational capability. Program officials expect to demonstrate the other six technologies during a prototype flight test, in late 2008, that will assess ABL's lethality. MDA has released about 94 percent of the engineering drawings for the prototype's design, which will be the basis for an initial operational capability during a future block if the test is successful. However, additional drawings may be needed if the design is enhanced or if problems encountered during flight-testing force design changes.



ABL Program

Technology Maturity

Only one of ABL's seven critical technologies—managing the high power beam—is fully mature. The program office assessed the remaining six technologies—the six-module laser, missile tracking, atmospheric compensation, transmissive optics, optical coatings, and jitter control--as nearly mature. According to program officials, all of these technologies are needed to provide the system with an initial operational capability.

The program office assessed the six-module laser as being close to reaching full maturity. In November 2004, the program demonstrated the simultaneous firing of all six laser modules. However, the initial operation of the laser was too short to make meaningful predictions of its power, and problems experienced during recent tests limited the duration of lasing. In December 2005, the program conducted a longer duration test of the laser and was able to sustain the beam for more than 10 seconds. The program also produced approximately 83 percent of the laser's design power, which, according to program officials, is sufficient to achieve 95 percent of lethal range against all classes of ballistic missiles.

The program recently completed a series of beam control/fire control flight tests and, as a result, has reassessed three of its critical technologies—transmissive optics, optical coatings, and jitter control--as nearing full maturity. The program plans to demonstrate all technologies in an operational environment during a flight test of the system prototype, referred to as lethal demonstration, in which ABL will attempt to shoot down a short-range ballistic missile. Challenges with integrating the laser and beam control/fire control subcomponents have delayed this test into late 2008.

Design Stability

We could not assess the design stability because ABL's initial capability will not be fully developed until the second aircraft is well underway. While the program has released 10,280 of the 10,910 engineering drawings for the prototype, it is unclear whether the design of the prototype aircraft can be relied upon as a good indicator of design stability for the second aircraft. More drawings may be needed if the design is enhanced or if problems encountered during flight testing force design changes.

Production Maturity

The program is producing a limited quantity of hardware for the system's prototype. However, we did not assess the production maturity of ABL because MDA has not made a production decision.

Other Program Issues

In fiscal year 2004, MDA directed the ABL program to restructure its prime contract, increase its cost ceiling, and refocus the contractor's efforts on making technical progress. However, recent technical challenges associated with the program's beam control/fire control flight test series and long duration laser testing are causing further cost growth and schedule slippage for the program. Since our last assessment in January 2005, ABL's planned budget through fiscal year 2009 increased by $483 million (9.4 percent), primarily in fiscal year 2009.

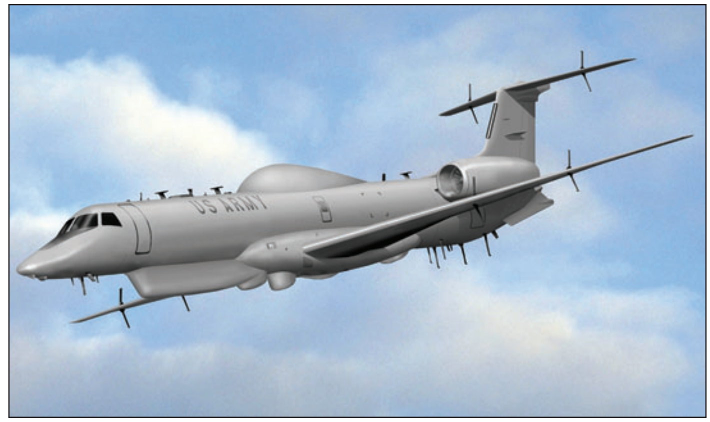
The program plans to award a contract for the second ABL aircraft, initially to include only trade studies, in fiscal year 2009. MDA has budgeted approximately $16 million for these trade study initiatives in an effort to determine the second aircraft system performance capabilities and to initiate the design of the second weapon system. However, program officials stated that the commitment to purchase a second aircraft will not be made until after the system prototype's lethal demonstration.

Agency Comments

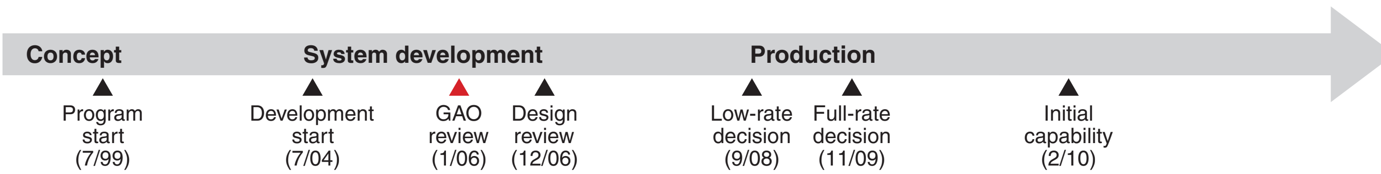
In commenting on a draft of this assessment, MDA provided technical comments, which were incorporated where appropriate.

Aerial Common Sensor (ACS)

The Army's ACS is an airborne reconnaissance, intelligence, surveillance, and target acquisition system and is being designed to provide timely intelligence data on threat forces to the land component commander. The ACS will replace the Guardrail Common Sensor and the Airborne Reconnaissance Low airborne systems. ACS will co-exist with current systems until it is phased in and current systems retire. The Navy will also acquire ACS to replace its current airborne intelligence platform, the EP-3.



Source: Lockheed Martin Corporation.



Program Essentials

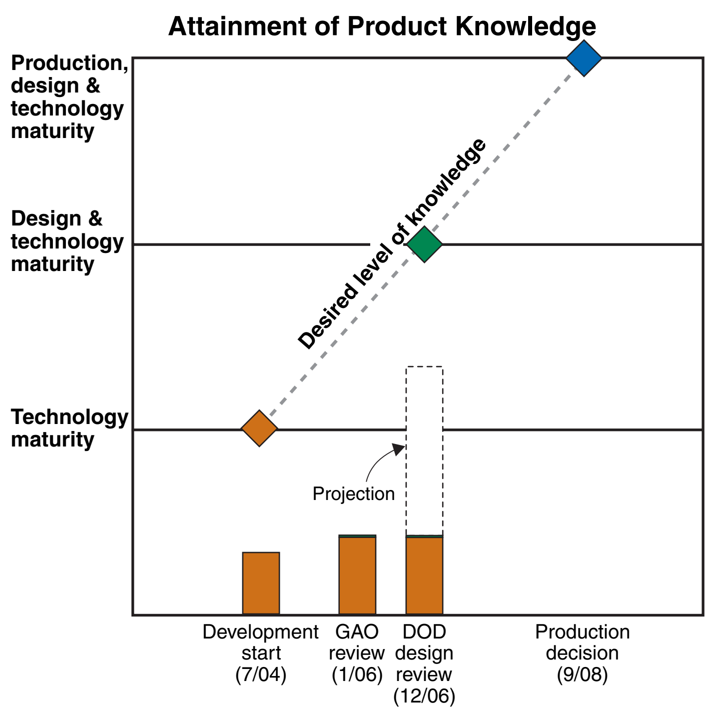
Prime contractor: Lockheed Martin
Program office: Fort Monmouth, N.J.
Funding needed to complete:
R&D: $879.1 million
Procurement: $2,892.9 million
Total funding: $3,775.6 million
Procurement quantity: 33

Program Performance (fiscal year 2006 dollars in millions)

	As of 07/2004	Latest 08/2005	Percent change
Research and development cost	$1,195.9	$1,152.8	-3.6
Procurement cost	$2,892.9	$2,892.9	0.0
Total program cost	$4,093.0	$4,049.2	-1.1
Program unit cost	$107.712	$106.559	-1.1
Total quantities	38	38	0.0
Acquisition cycle time (months)	127	127	0.0

These costs and quantities are expected to change due to the ACS program restructuring, as is the acquisition timeline.

Due to a significant increase in the weight to integrate the prime mission equipment on the platform, the Army terminated the development contract. However, the ACS program will continue although development effort will be scaled back. At development start, only one of ACS' six critical technologies was fully mature and two more were nearing maturity. Currently, one additional technology is nearing maturity. The Army expected to have demonstrated the maturity of all but one critical technology by the design review, which was scheduled for December 2006. The program office estimated that 50 percent of drawings would have been releasable at that time. The Army plans to reevaluate requirements, possibly eliminating some, which will likely affect the system's technologies, design, cost, and schedule.



ACS Program

Technology Maturity

Only one of ACS's six critical technologies was mature when the program started development in July 2004 and two more were nearing maturity. When the Army terminated the development contract, one additional technology was nearing maturity. The maturity of one of the remaining technologies was tied to the development of the airborne version of the Joint Tactical Radio System, which would not have been available until after ACS was fielded. The Army expected that all of the critical technologies except the one tied to the radios would be fully mature by 2006. It is not clear at this time which requirements might be eliminated or the resulting impact to the technology maturity.

Design Stability

The program office estimated that 50 percent of the drawings expected for ACS would have been releaseable by the design review, which was scheduled for December 2006. However, solving the problem of the increased weight to integrate the prime mission equipment will likely affect the system's design.

Other Program Issues

In December 2004, five months after the program began development, the contractor informed the Army that the weight to integrate prime mission equipment onto the selected platform had exceeded the structural limits of the aircraft. In January 2005, a contractor team including Lockheed Martin and the integration subcontractor initiated a risk mitigation strategy to address the problem. At the Army's and Navy's direction, the contactor also began to explore using a larger aircraft. In May 2005, the program manager submitted a program deviation report notifying DOD that the issue would likely lead to a nonrecoverable program schedule breach. At the Army's request, the Navy convened a review team to study the problem without advocating a particular solution. In September the review team reported back to the Army. The team identified several factors that contributed to the problem, including inadequate prime contractor program management as evidenced by instability on the contractor's engineering team, lack of design specifications for the subcontractors, and insufficient exploration of the integration challenges during technology development.

In September 2005, the Army ordered the contractor to stop all work under the current contract except for work necessary to provide a written plan with solutions and alternative strategies to maximize performance and minimize cost and schedule impacts to the government. In November, the contractor briefed the Army on three courses of action: refine the configuration to reduce requirements and keep the current platform; allow the contractor to acquire a larger platform that can accommodate the current prime mission equipment; or decouple the platform from system development and have the contractor deliver only the prime mission equipment. The Army rejected all three solutions and in January 2006, terminated the development contract for the convenience of the government. The Army has not yet estimated the effect to the development cost and schedule.

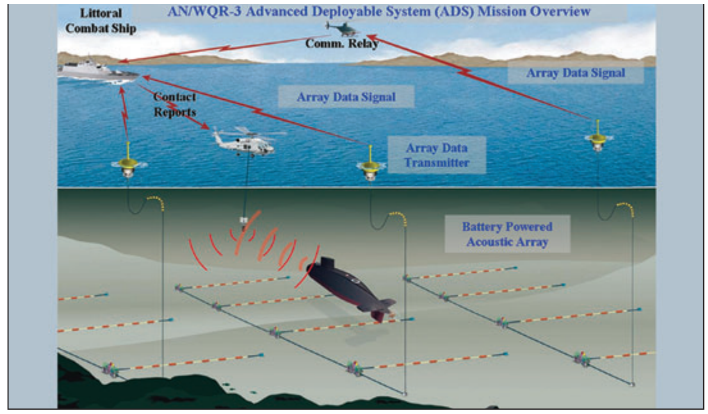
Recent funding cuts appear to reduce the total program cost by $43.1 million in current year dollars. Reductions were due to reprogramming and changes in inflation indices.

Agency Comments

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

Advanced Deployable System (ADS)

The Navy's ADS is a rapidly deployable undersea surveillance system, scheduled for initial deployment as part of the antisubmarine warfare mission package on the Littoral Combat Ship (LCS). ADS is designed to detect, track, and report conventional and nuclear submarines in shallow waters by laying sensor fields on the ocean floor that send data back to the LCS for processing and analysis. We assessed the entire system, including its sensors, sensor installation system, in-buoy processors, and onboard analysis and reporting system.



Source: ADS Program Office.

Concept — Program start (12/92)

System development — Development start (11/05); GAO review (1/06); Design review (10/06); Initial capability (9/07)

Production — Low-rate decision (4/08); Full-rate decision (9/09); Last procurement (unknown)

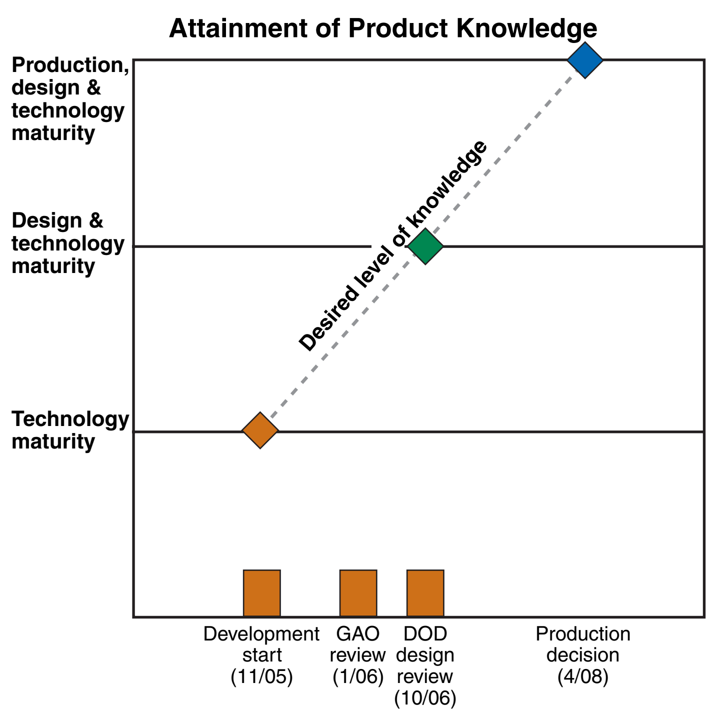
Program Essentials

Prime contractor: Lockheed Martin
Program office: San Diego, Calif.
Funding needed to complete:
- R&D: $219.6 million
- Procurement: $581.3 million
- Total funding: $809.7 million
- Procurement quantity: 15

Program Performance (fiscal year 2006 dollars in millions)

	As of NA	Latest 12/2005	Percent change
Research and development cost	NA	$709.5	NA
Procurement cost	NA	$595.6	NA
Total program cost	NA	$1,318.0	NA
Program unit cost	NA	$87.869	NA
Total quantities	NA	15	NA
Acquisition cycle time (months)	NA	25	NA

The ADS program entered system development in November 2005 with none of its four critical technologies mature. The sensors and the on-board processing system are more mature because they leverage existing Navy technology. Program officials identified several remaining risks for ADS, however, such as the ability of the system to relay data from the in-buoy processor to the on-board analysis and reporting system and the successful deployment and installation of sensors. According to the program office, all technologies are expected to reach maturity in 2007. ADS is expected to be fully operational with the delivery to LCS in 2009. We were unable to assess design stability due to a lack of design data at this time.



ADS Program

Technology Maturity

None of ADS's four critical technologies reached maturity by the start of system development in November 2005. Program officials stated, however, that the maturity of all critical technologies will be demonstrated through complete end-to-end system testing in fiscal year 2007.

Two critical technologies--the sensor subsystem, consisting of sensors and fiber optic connecting cables, and the on-board analysis and reporting system (ARS)--are relatively mature, in part because they leverage existing technologies. The ARS is comprised of previously developed software and only requires repackaging and integration into the ADS. However, although the ARS currently meets its requirements, an ongoing challenge is developing enhanced automation tools to reduce operator workload, due to limited space on the LCS. The sensor system is relatively mature because it uses sensors from previous program development. Prototypes of both technologies have already been tested in the ocean environment.

The remaining two critical technologies are less mature, and face several risks and challenges. The in-buoy processor system, which compresses and processes data from the ocean floor before sending it to the LCS, is still in early development. According to program officials, the system's ability to transfer data to the ARS is a high-risk area. Recent risk reduction efforts aimed to address this issue. The system may also employ a reduced-range radio technology as a fallback technology. Additional development challenges for ADS include improving the overall survivability of the buoys and increasing their endurance.

The sensor installation system, which deploys and installs sensors on the ocean bottom, is complicated by its dependence on many smaller technologies. Successful installation of sensors, as well as the survivability of connector cables--from fish bites and trawling, for example--are major development concerns. Back-up options for sensor installation include deploying the arrays manually, as demonstrated in a 2003 test or using a deployment vehicle that was demonstrated in a fleet exercise in 1999. Recent risk reduction efforts, however, have improved the system's performance. In 2004 and 2005, for example, sensor deployment and high-speed cable pullout were demonstrated successfully.

Design Stability

We were unable to assess ADS design stability due to a lack of design data at this time.

Other Program Issues

Originally designed for deployment on another platform, the ADS program was redirected in 2003 to focus its initial increment on deployment from the LCS. This developmental change caused some redesign of the program, but incorporated previously developed sensors and processing algorithms. Moreover, although future spirals will provide the capability to deploy ADS from an alternate platform, the first increment of ADS is wholly focused on deployment from the LCS.

The LCS also only allows for limited manpower to support ADS processing operations. To maximize efficiency, operators may need to be trained in multiple systems of the LCS's antisubmarine warfare mission area. ADS program officials are concerned that operators may not have the expertise necessary to employ ADS effectively.

Agency Comments

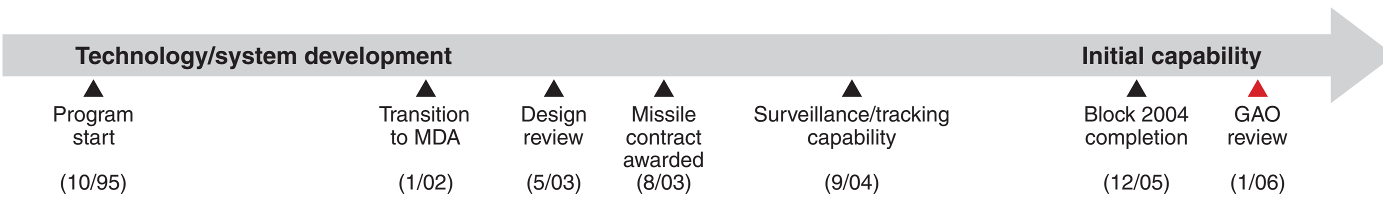
In commenting on this assessment, the Navy stated that according to its standards two ADS technologies—the sensor subsystem and the ARS—are already mature. According to Navy officials, they evaluate ADS technology maturity based on standards set by a Naval research group, which considers technologies mature when they have been demonstrated in a relevant, rather than an operational environment.

The Navy stated that it is making progress in reducing risks on key technologies through the execution of a Technology Maturity Plan. Specifically, Navy officials stated that they are mitigating system risks through additional testing of the sensor installation system and risk mitigation planning.

Aegis Ballistic Missile Defense (Aegis BMD)

MDA's Aegis BMD element is a sea-based missile defense system being developed in incremental, capability-based blocks to protect deployed U.S. forces, allies, and friends from short- and medium-range ballistic missile attacks. Key components include the shipboard SPY-1 radar, hit-to-kill missiles, and command and control systems. It will also be used as a forward-deployed sensor for surveillance and tracking of intercontinental ballistic missiles. We assessed only Block 2004 of the element's missile, the Standard Missile 3 (SM-3).

Source: Aegis BMD Program Directorate.



Program Essentials

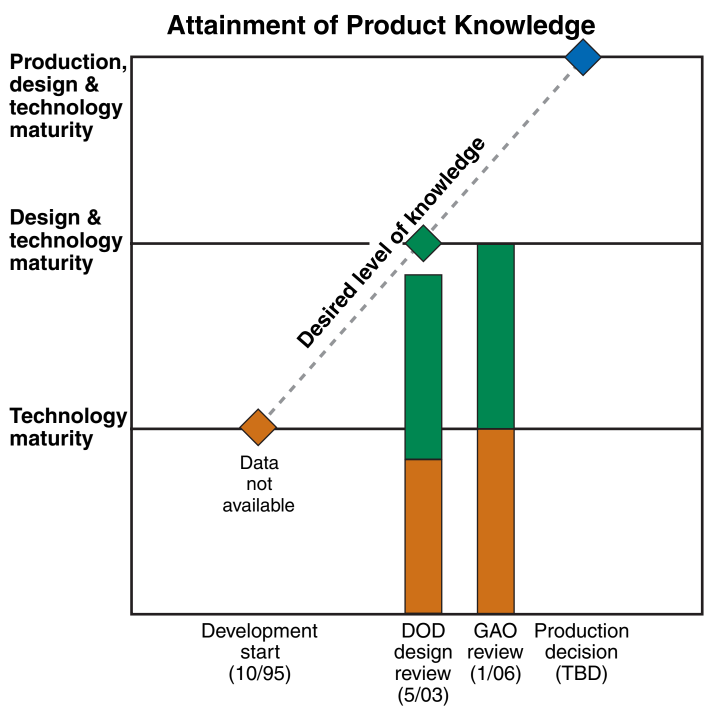
Prime contractor: Lockheed Martin (AWS), Raytheon (SM-3)
Program office: Arlington, Va.
Funding FY06-FY11:
- R&D: $4,962.1 million
- Procurement: $0.0 million
- Total funding: $4,962.1 million
- Procurement quantity: NA

Program Performance (fiscal year 2006 dollars in millions)

	As of 11/2003	Latest 07/2005	Percent change
Research and development cost	$7,213.0	$8,489.9	17.7
Procurement cost	$0.0	$0.0	0.0
Total program cost	$7,213.0	$8,489.9	17.7
Program unit cost	NA	NA	NA
Total quantities	NA	65	NA
Acquisition cycle time (months)	NA	NA	NA

Costs and quantities are for all known blocks from the program's inception through fiscal year 2009. Total known program cost through fiscal year 2011 is $10,038.4 million and total quantities are 101.

According to program officials, the Block 2004 increment of SM-3 missiles being fielded during 2004-2005 has mature technologies and a stable design. However, the program deferred full functionality of the missile's Solid Divert and Altitude Control System, which maneuvers the missile's kinetic warhead to its target, to a future upgrade. Program officials noted that even with reduced capability, the first increment of missiles provide a credible defense against a large population of the threat. All drawings for the first increment of missiles have been released to manufacturing. The program is not collecting statistical data on its production process but is using other means to gauge production readiness.



Aegis BMD Program

Technology Maturity

Program officials estimate that all three technologies critical to the SM-3 missile are mature. These technologies–the missile's third stage rocket motor and the kinetic warhead's infrared seeker and Solid Divert and Attitude Control System (SDACS)–have been tested in flight. While the first two technologies were fully demonstrated in flight tests, the SDACS, which steers the kinetic warhead, was only partially demonstrated. The SDACS operation in "pulse mode," which increases the missile's divert capability, failed during a June 2003 flight test. According to program officials, the test failure was likely caused by a defective subcomponent within the SDACS, a problem that should be corrected through specific design modifications. To implement these corrective actions, the program is deferring full functionality of the missile's SDACS technology to the next upgrade of the hit-to-kill missile. Program officials note that only partial functionality of the SDACS is required for Block 2004, which has been successfully demonstrated in flight tests.

Design Stability

Program officials reported that the design for the first 11 SM-3 missiles being produced during Block 2004 is stable with 100 percent of its drawings released to manufacturing. The program plans to implement design changes in subsequent blocks (delivered during 2006-2007) to resolve the SDACS failure witnessed in the June 2003 flight test.

Production Maturity

We did not assess the production maturity of the SM-3 missiles being procured for Block 2004. Program officials stated that given the low quantity of missiles being produced, statistical process control data on the production process would have no significance. The Aegis BMD program is using other means to assess progress in production and manufacturing, such as integrated product team reviews, risk reviews, Engineering Manufacturing Readiness Levels, and missile metrics.

Other Program Issues

The Aegis BMD element builds upon the existing capabilities of Aegis-equipped Navy cruisers and destroyers. Planned hardware and software upgrades to these ships will enable them to carry out the ballistic missile defense mission. In particular, the program is working to upgrade Aegis destroyers for surveillance and tracking of intercontinental ballistic missiles. Because this function is new to the element, the program has faced a tight schedule to develop and test this added functionality during the Block 2004 time frame. Although the program aims to upgrade ten destroyers as part of its Block 2004 increment, this new functionality has been exercised in a limited number of flight tests and has never been validated in an end-to-end flight test with the GMD system, for which it is providing long range surveillance and tracking. Since our last assessment, Aegis BMD's planned budget through fiscal year 2009 increased by $453.5 million (5.6 percent), primarily in fiscal years 2008 and 2009.

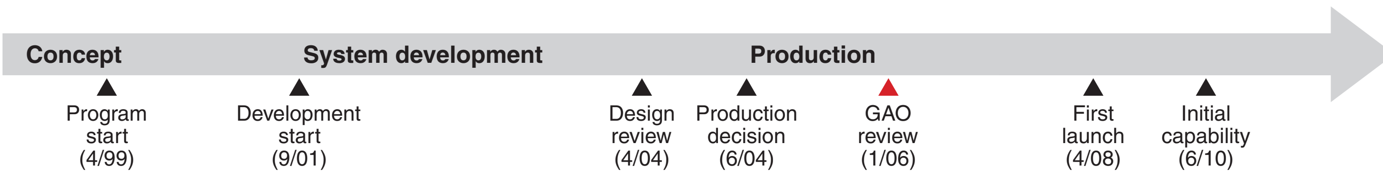
Agency Comments

The Program Office provided technical comments to a draft of this assessment, which were incorporated as appropriate.

Advanced Extremely High Frequency (AEHF) Satellites

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 satellites and a mission control segment. Terminals used to transmit and receive communications are acquired separately by each service. AEHF is an international partnership program that includes Canada, United Kingdom, and the Netherlands. We assessed the satellite and mission control segments.

Source: Advanced EHF Program Office.



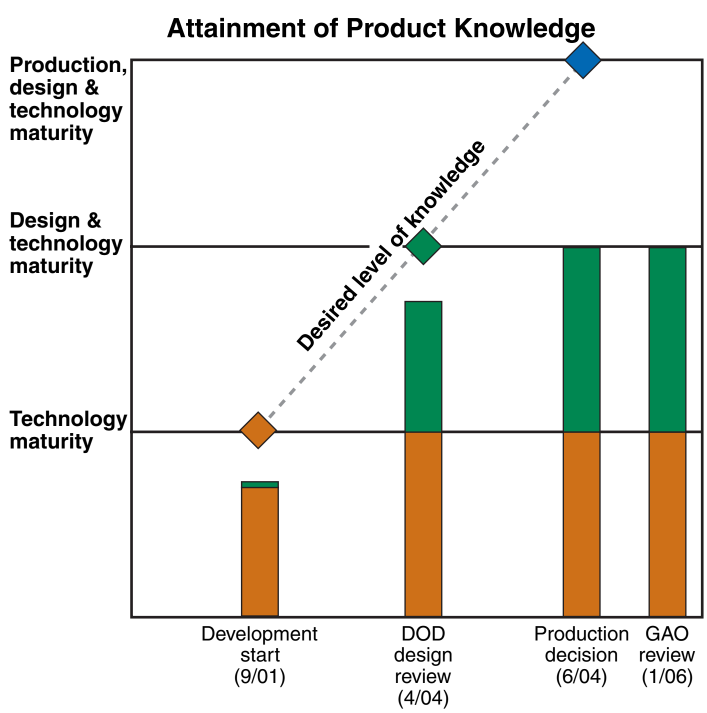
Program Essentials

Prime contractor: Lockheed Martin
Program office: El Segundo, Calif.
Funding needed to complete:
- R&D: $2,108.2 million
- Procurement: $538.5 million
- Total funding: $2,646.7 million
- Procurement quantity: 1

Program Performance (fiscal year 2006 dollars in millions)

	As of 10/2001	Latest 08/2005	Percent change
Research and development cost	$4,366.3	$5,631.4	29.0
Procurement cost	$1291.5	$618.4	-52.1
Total program cost	$5,657.8	$6,249.9	10.5
Program unit cost	$1,131.568	$2,083.293	84.1
Total quantities	5	3	-40.0
Acquisition cycle time (months)	111	134	20.7

According to the program office, the AEHF program's technologies are mature and the design is stable. However, in late 2004 the program was delayed 12 months because key cryptographic equipment would not be delivered in time and to allow the program time to replace some critical electronic components and add testing. Program officials stated the 12-month slip should allow ample time to resolve the issues, but added significant cost. Total program cost increased about $1 billion. The program still faces schedule risk due to the continued concurrent development of two critical path items managed and developed outside the program. Current plans are to meet full operational capability with three AEHF satellites and the first Transformational Satellite Communications System (TSAT) satellite, but additional AEHF satellites may be acquired if there are deployment delays with TSAT.



AEHF Program

Technology Maturity

According to the program office, all of the 14 critical technologies are mature, having been demonstrated in a relevant environment and most progressing into environmental and functional performance testing.

Design Stability

AEHF's design is stable. Virtually all of the expected design drawings have been released. The program completed its system level critical design review in April 2004.

Production Maturity

Production maturity could not be assessed as the program office does not collect statistical process control data.

Other Program Issues

In late 2004, the concurrent development of two critical path items led to schedule delays and cost increases. The program was restructured in October 2004, when the National Security Agency did not deliver key cryptographic equipment to the payload contractor in time to meet the launch schedule. The restructuring added 12 months to the program to allow time to resolve the cryptographic delivery issues and resolve other program problems including replacement of critical electronic components and additional payload testing. Delaying the launches and resolving these issues added about $800 million to the program. Earlier cost increases brought the total increase to about $1 billion, incurring a Nunn-McCurdy breach in December 2004 (10 U.S.C. 2433) at the 15 percent threshold.

The program still faces schedule risk due to the continued concurrent development of two critical path items developed and managed outside the program; the cryptographic components developed and produced by the National Security Agency and the Command Post Terminals managed by another Air Force Program Office. During 2005, the program developed emulators to simulate key cryptographic equipment to allow payload testing and integration to continue, and National Security Agency began delivery of some actual components, meeting its revised delivery dates.

Program officials told us the mission control segment continues to meet or exceed its schedule and performance milestones. In addition, the program made progress in several areas including: completion of end-to-end testing for the payload and terminal communications utilizing test terminals, completion of static load testing on the satellite structure, and delivery of the flight cryptographic hardware, which has been installed and tested on the first satellite.

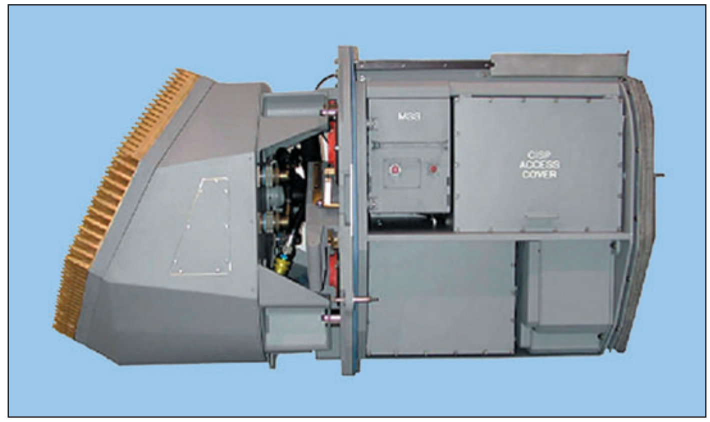
Three AEHF satellite launches are scheduled for 2008, 2009, and 2010. In December 2002, satellites four and five were deleted from the program with the intention of using TSAT to achieve full operational capability. However, the AEHF contract contains options to buy additional satellites if there are deployment problems with TSAT.

Agency Comments

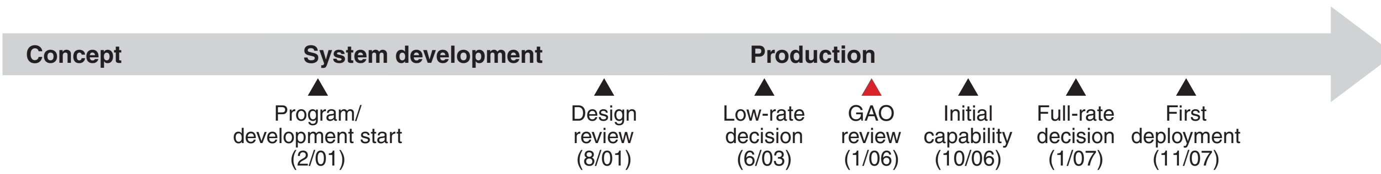
The Air Force provided technical comments, which were incorporated as appropriate.

Active Electronically Scanned Array Radar (AESA)

The Navy's AESA radar is one of the top upgrades for the F/A-18E/F aircraft. It is to be the aircraft's primary search/track and weapon control radar and is designed to correct deficiencies in the current radar. According to the Navy, the AESA radar is key to maintaining the Navy's air-to-air fighting advantage and will improve the effectiveness of the air-to-ground weapons. When completed, the radar will be inserted in new production aircraft and retrofitted into lot 26 and above aircraft.



Source: U.S. Navy.



Program Essentials

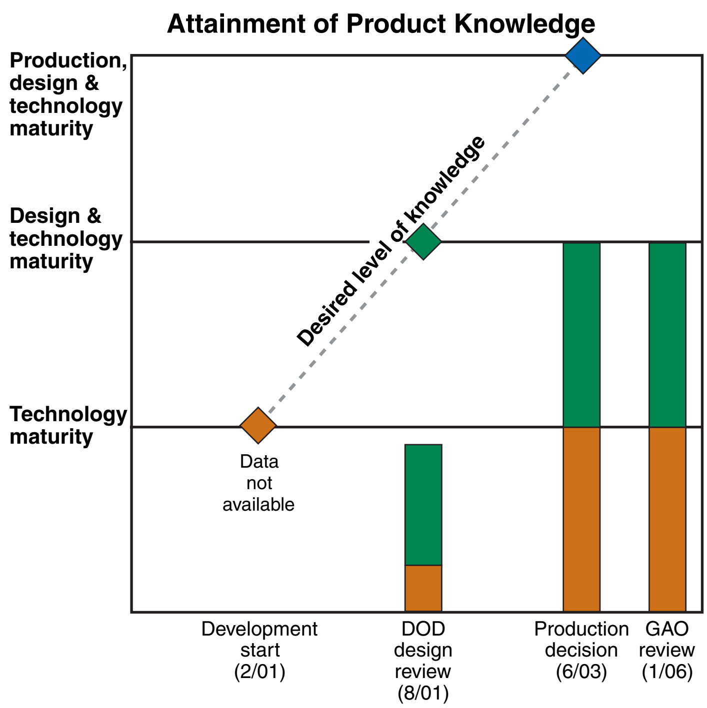
Prime contractor: McDonnell Douglas, Corp.
Program office: Patuxent River, Md.
Funding needed to complete:
- R&D: $76.4 million
- Procurement: $1,483.7 million
- Total funding: $1,560.1 million
- Procurement quantity: 373

Program Performance (fiscal year 2006 dollars in millions)

	As of 02/2001	Latest 12/2005	Percent change
Research and development cost	$544.8	$611.1	12.2
Procurement cost	$1,747.9	$1,808.0	3.4
Total program cost	$2,292.6	$2,419.1	5.5
Program unit cost	$5.524	$5.829	5.5
Total quantities	415	415	0.0
Acquisition cycle time (months)	69	68	-1.5

Procurement funding for the radar is included in the funding for the F/A-18E/F and EA-18G aircraft programs.

The AESA radar's critical technologies appear to be mature and the design appears stable. However, radar development continues during production. The program is tracking a number of risks with the technical performance of the radar. If problems are discovered, design changes could be required while the radar is in production. Software development continues to be the program's top challenge. Problems in developing radar software have resulted in deferring several advanced capabilities until future software configurations. Radar production faces a high risk in 2006 because a material for one of the radar's critical technologies is expected to go out of production. Several other development and production risks have not been resolved.



AESA Program

Technology Maturity

A technology readiness assessment for the radar in fiscal year 2004 determined that the four critical technologies were mature. To further ensure technology maturity, a final technology assessment was held in November 2005.

Design Stability

Although the AESA design appears to be stable, development of the radar has continued during production. According to program officials, radar software continues to be the top program challenge. Several advanced radar capabilities have been deferred to future software configurations. The radar schedule could not be extended because it is directly tied to the F/A-18E/F schedule. According to the program office, these capabilities will not be deferred beyond the first deployment, and no key performance parameters will be affected by the deferral. Since the start of development, the number of lines of software code has increased by 17 percent, and software development costs have increased by over 40 percent.

According to a program office risk assessment, other development risks could result in design changes: the radar may not be able to track sufficient targets simultaneously or detect tail targets at low altitude; radiation emissions may interfere with F/A-18E/F weapon systems; and the radar power supply may not prevent voltage modulation on the aircraft power system. Also, the radar simulation model integrated into the F/A-18 training simulator may not accurately represent radar operation and performance. Mitigation plans are in place to address the design risks and, according to the program office, the likelihood of a design change is minimal due to over 500 flights with the AESA radar.

Production Maturity

We could not assess production maturity because statistical process control data are not being collected. Instead, manufacturing processes continue to be monitored and controlled at each manufacturing center and laboratory. Twenty percent of the 415 radars are to be procured during 4 low-rate production runs. The radar's third production run has been approved. Nine radars had been delivered as of August 2005. Most radars will be installed in F/A-18E/Fs on the aircraft production line, but 135 radars are to be retrofitted into already produced aircraft.

Radar production continues to face a number of risks. A high risk involves a foam material for the radar's wideband radome, a critical technology. The manufacturer plans to stop producing the material in the 2006 time frame, which would affect future radar production. The program office plans to mitigate this risk by making a lifetime buy of the foam material. According to the program risk assessment, other risks include whether: radar manufacturing capacity can ramp up enough to meet production and reliability problems with a radar critical technology will allow initial radars to meet a specification. Also, low-rate production is exceeding design-to-cost and firm, fixed-price costs. For example, the estimate at completion for the radar contract is projected to overrun the target cost by up to 34 percent.

Other Program Issues

In response to a 1999 DOD directive, a requirement was added to the radar for antitamper protection to guard against exploitation of critical U.S. technologies. According to the program office, a successful critical design review for this requirement was completed in November 2005. While officials said there is a requirement for this protection to have no effect on radar performance, operational tests of antitamper models may identify problems that require design changes to the protection package. By then, 84 radars are expected to have been produced.

Agency Comments

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

Advanced Precision Kill Weapon System (APKWS)

The Army's APKWS is a precision-guided, air-to-surface missile designed to engage soft and lightly armored targets. The system is intended to add a new laser-based seeker to the existing Hydra 70 Rocket System and is expected to provide a lower cost, accurate alternative to the Hellfire missile. Future block upgrades are planned to improve system effectiveness. We assessed the laser guidance technology used in the new seeker.

Source: Joint Attack Munition Systems Project Office.

Concept	System development			Production		
	Program/ development start (12/02)	GAO review (1/06)	Design review (6/06)	Low-rate decision (9/08)	Initial capability (6/11)	Last procurement (unknown)

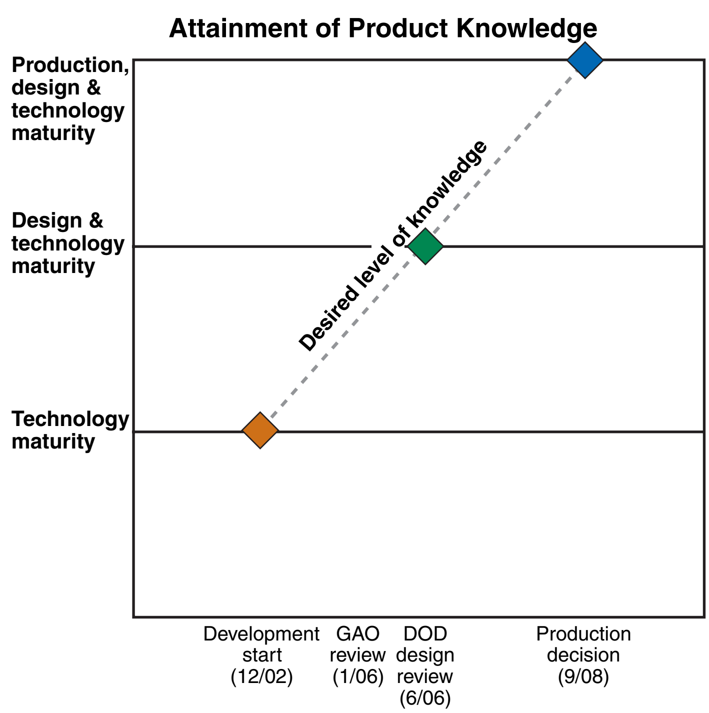
Program Essentials

Prime contractor: TBD
Program office: Huntsville, Ala.
Funding needed to complete:
R&D: $56.1 million
Procurement: $1,329.6 million
Total funding: $1,385.6 million
Procurement quantity: 71,565

Program Performance (fiscal year 2006 dollars in millions)

	As of 12/2002	Latest 08/2005	Percent change
Research and development cost	$121.4	$139.8	15.1
Procurement cost	$1,599.8	$1,336.4	-16.5
Total program cost	$1,881.8	$1,476.2	-21.6
Program unit cost	$.021	$.021	-2.0
Total quantities	89,420	71,565	-20.0
Acquisition cycle time (months)	60	102	70.0

Since our assessment of APKWS last year, the Milestone Decision Authority curtailed the program. We reported the APKWS entered development and held its design review before demonstrating its critical guidance technology was fully mature and that initial system-level testing identified problems with the design. According to program officials, placement of the laser seeker proved to be problematic. The combination of development cost overruns, a projected schedule slip of 1-2 years, unsatisfactory contract performance, and environmental issues resulted in curtailment of the initial APKWS program in January 2005. Program officials expect to award the contract for a restructured APKWS program in the second quarter of fiscal year 2006. Due to program uncertainty, we were unable to assess design, technology, or production maturity.



APKWS Program

Technology Maturity

At the time of our last report, APKWS had one critical technology--laser guidance. Since the laser technology was employed on other platforms, program officials considered it to be mature. However, according to program officials, integration of the laser on the fins rather than in the head of the missile proved to be more problematic then originally estimated. The configuration difficulty presented problems that the contractor could not overcome and keep the missile within cost and on schedule. The integration issue contributed to the cost overrun and protracted schedule, which subsequently led to program curtailment and restructuring. Program officials stated they have since identified several laser seeker and guidance and control systems suitable for the Guided Rocket requirement. Furthermore, program representatives feel they have sufficient information to proceed with the critical design review immediately after contract award. Because the contractor and the specific technical approach to be pursued are yet to be determined, we could not assess the maturity of the design, technology, or production for the restructured program.

Other Program Issues

Although the APKWS program was scheduled to start production of the rocket in fiscal year 2006, a number of program problems related to development cost overruns, schedule slippage, and contract performance resulted in the Army Program Executive Officer for Missiles and Space curtailing the program in January 2005. Following curtailment, the Vice Chief of Staff of the Army validated the requirements and approved a restructured APKWS program and timeline. Program officials released a Draft Request for Proposal in June 2005 and are expecting to award a new contract for the restructured APKWS program during the second quarter of fiscal year 2006. According to program officials, the current fiscal year 2006 President's budget was prepared and submitted prior to the Milestone Decision Authority's decision to curtail the initial APKWS contract and restructure the program. Ongoing program office efforts to align program funding to the new structure have not yet been completed.

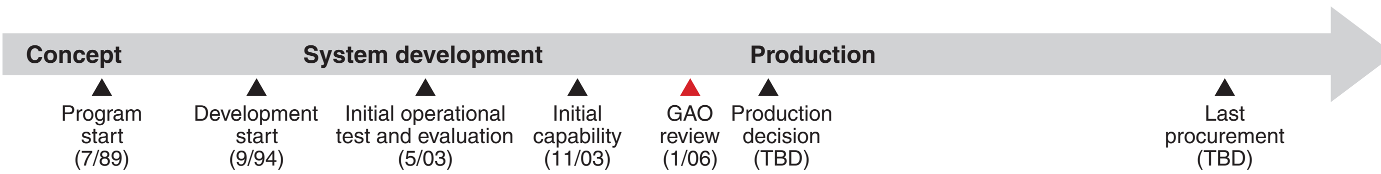
Agency Comments

The Army provided technical changes, which were incorporated as appropriate.

Advanced SEAL Delivery System (ASDS)

The Special Operations Forces' ASDS is a battery-powered dry interior hybrid combatant submersible for clandestine insertion/extraction of Navy SEALs and their equipment. It is carried to a deployment area by specially configured 688-class submarines. ASDS is intended to provide increased range, payload, on-station loiter time, endurance, and communication/sensor capacity over current submersibles. The 65-foot-long 8-foot-diameter ASDS is operated by a two-person crew and includes a lock out/lock in diving chamber.

Source: U.S. Navy.



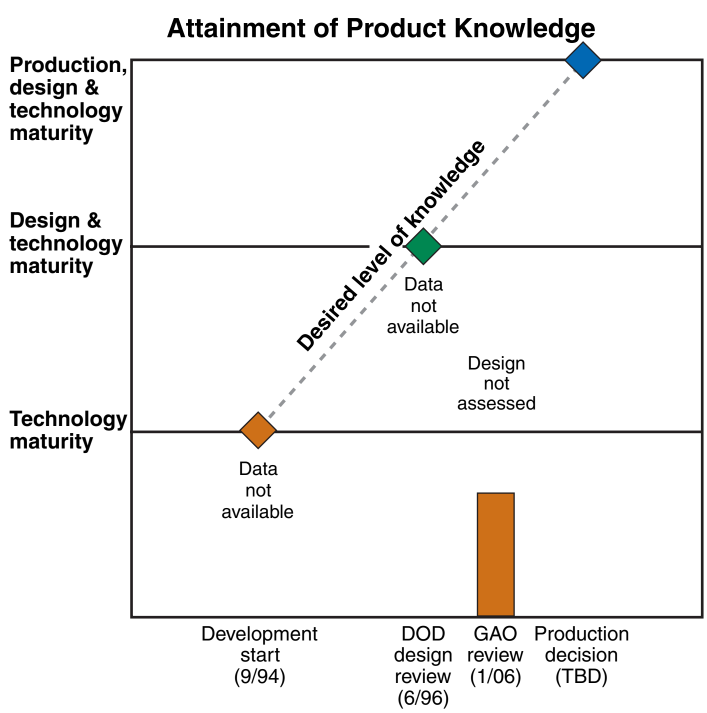
Program Essentials

Prime contractor: Northrop Grumman Electronic Systems
Program office: Washington, D.C.
Funding needed to complete:
- R&D: TBD
- Procurement: TBD
- Total funding: TBD
- Procurement quantity: 0

Program Performance (fiscal year 2006 dollars in millions)

	As of 09/1994	Latest 01/2006	Percent change
Research and development cost	$146.7	$499.3	240.3
Procurement cost	$130.0	$117.8	-9.4
Total program cost	$291.4	$652.5	123.9
Program unit cost	$97.134	$652.476	571.7
Total quantities	3	1	-66.7
Acquisition cycle time (months)	NA	TBD	NA

The ASDS program is being restructured due to reliability problems with the first boat, and the production decision for additional units has been cancelled. Restructuring includes developing a reliability improvement plan and conducting a critical system review to identify issues that need to be addressed. ASDS design changes since our last report include replacing the silver-zinc battery with a lithium-ion battery, replacing the aluminum tail with a titanium tail, and several other modifications. At-sea development testing of the lithium-ion battery has been completed. Acoustic, or noise level problems, are being addressed; however, this requirement does not have to be met until delivery of the second ASDS boat. Until ASDS reliability is assessed, problems are addressed, and operational testing is completed, ASDS technology maturity and design stability remain uncertain.



ASDS Program

Technology Maturity

The program office identified three ASDS critical technologies. Although two of the three technologies were mature at the time of our last assessment, since that time the aluminum tail (mature) has been replaced with a titanium tail. The silver-zinc battery was replaced with a lithium-ion battery. In an August 2005 at-sea development test of the battery, requirements for speed, range, and endurance were exceeded. Acoustic, or noise level problems, are being addressed. In earlier tests, the ASDS propeller was the source of the most significant noise, and a new composite propeller was installed before operational test and evaluation in 2003. Although program officials believe the improved propeller will significantly reduce the ASDS acoustic signature, precise acoustic measurements are incomplete. Other acoustic issues will be addressed on a time-phased basis because the acoustic requirement has been deferred until delivery of the second boat.

Design Stability

The ASDS experienced a propulsion-related failure during Follow-on Operational Test and Evaluation in October 2005, and the Navy decertified ASDS from operational test readiness. The Navy is investigating the causes of the failure and plans to complete repairs and post-repair testing in January 2006. On November 30, 2005, the United States Special Operations Command (SOCOM) and the Navy announced the restructuring of the ASDS program to focus on correcting reliability deficiencies with the first boat and to conduct verification testing of improvements before continuing operational testing. The ASDS Reliability Action Panel, a panel of submarine and submersible technical experts from government and industry chartered by SOCOM and the Navy in September 2005, noted that there were numerous examples of unpredicted component reliability problems and failures resulting from design issues and that operational testing should not be resumed until completion of a detailed review of mission critical systems.

Consequently, the production decision for additional units has been cancelled until the first boat's reliability has been improved. Under the ASDS restructuring plan, the critical system review is expected to identify known problems and other potential issues and identify what design changes are needed. A Vulnerability Assessment Report assessing ASDS survivability design features was issued in September 2005 and a Capabilities Production Document (to replace the June 2004 ASDS operational requirements document) is under review. Until the program's critical system review is completed, all requirements are addressed, technical problems are solved, and testing is completed, we believe the ASDS final design will remain uncertain and may have cost and schedule implications. Because the ASDS program is being restructured, we are not assessing the current level of ASDS design stability.

Other Program Issues

In December 2004 SOCOM reduced the ASDS program quantity to three units due to resource constraints. However, it affirmed that the operational requirements document remained valid at six ASDS vehicles.

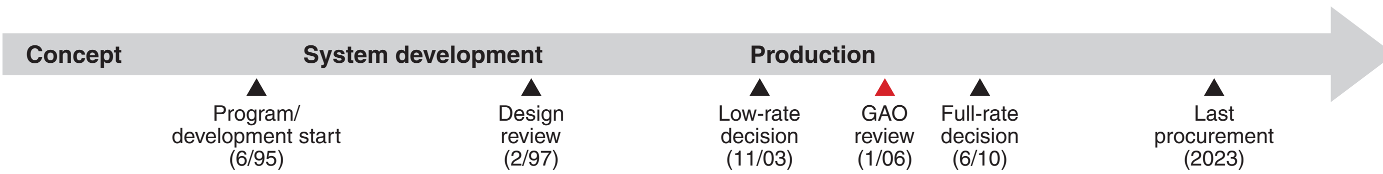
Agency Comments

The Navy concurred with our assessment and provided updated costs, which were incorporated as appropriate.

Advanced Threat Infrared Countermeasure/Common Missile Warning System

The Army's and Special Operations' ATIRCM/CMWS is a component of the Suite of Integrated Infrared Countermeasures planned to defend U.S. aircraft from advanced infrared-guided missiles. The system will be employed on Army and Special Operations aircraft. ATIRCM/CMWS includes an active infrared jammer, missile warning system, and countermeasure dispenser capable of loading and employing expendables, such as flares, chaff, and smoke.

Source: BAE Systems.



Program Essentials

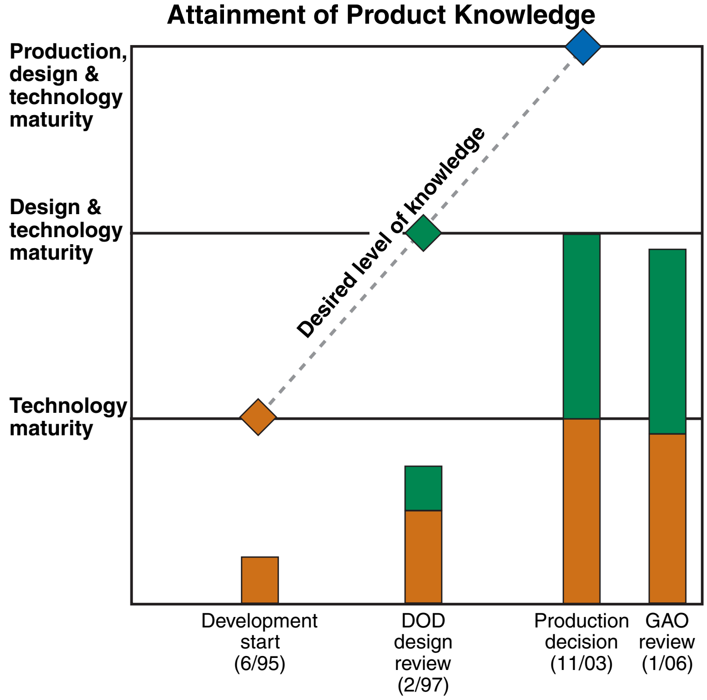
Prime contractor: BAE Systems North America
Program office: Huntsville, Ala.
Funding needed to complete:
- R&D: $71.9 million
- Procurement: $3,605.4 million
- Total funding: $3,677.4 million
- Procurement quantity: 2,458

Program Performance (fiscal year 2006 dollars in millions)

	As of 03/1996	Latest 11/2005	Percent change
Research and development cost	$595.8	$652.2	9.5
Procurement cost	$2,436.3	$4,161.4	70.8
Total program cost	$3,032.1	$4,813.6	58.8
Program unit cost	$.980	$1.341	36.9
Total quantities	3,094	3,589	16.0
Acquisition cycle time (months)	Classified	Classified	Classified

The ATIRCM/CMWS program entered production in November 2003 with technologies mature and designs stable. However, one of the five critical technologies was recently downgraded due to continued technical difficulties. Currently, the program's production processes are at various levels of control. The CMWS portion of the program entered limited production in February 2002 to meet urgent deployment requirements. However, full-rate production for both components was delayed because of reliability problems. Over the past several years, the program has had to overcome cost and schedule problems brought on by shortfalls in knowledge. Key technologies were demonstrated late in development and only a small number of design drawings were completed by design review. At the low rate production decision point, the Army developed a new cost estimate reducing program procurement cost substantially.

Attainment of Product Knowledge



ATIRCM/CMWS Program

Technology Maturity

The five critical technologies were considered mature until a government/industry team recently downgraded the maturity level of the infrared jamming head due to technical issues. Additionally, the other four technologies did not mature until after the design review in February 1997. Most of the early technology development effort focused on the application to rotary wing aircraft. When system development began in 1995, requirements were expanded to include Navy and Air Force fixed wing aircraft. This change caused problems that contributed to cost increases of over 150 percent. The Navy and the Air Force subsequently dropped out of the program, but the Navy and the Army are currently pursuing future joint production planning.

Design Stability

The basic design of the system is complete with 100 percent of the drawings released to manufacturing. The design was not stable at the time of the design review, with only 22 percent of the drawings complete due to the expanded requirements. Two years after the design review, 90 percent of the drawings were released and the design was stable. This resulted in inefficient manufacturing, rework, additional testing, and a 3-year schedule delay.

Production Stability

Production maturity could not be assessed based on the information provided by the program office. According to program officials, the program has 21 key manufacturing processes in various phases of control (7 CMWS and 14 ATIRCM). The CMWS production portion of the system has stabilized and benefited from increased production rates. Also, processes supporting both ATIRCM and CMWS will continue to be enhanced as data is gathered and lessons learned will be included in the processes. The Army entered limited CMWS production in February 2002 to meet an urgent need. Subsequently, full rate production was delayed for both components due to reliability testing failures. The program implemented reliability fixes to six production representative subsystems for use in initial operational test and evaluation. These systems were delivered in March 2004. The full-rate production decision for the complete system was recently delayed until June 2010 due to ATIRCM performance issues.

Other Program Issues

The Army uses the airframe as the acquisition quantity unit of measure even though it is not buying an ATIRCM/CMWS system for each aircraft. When the program began, plans called for putting an ATIRCM/CMWS on each aircraft. Due to funding constraints, the Army reduced the number of systems to be procured and will rotate the systems to aircraft as needed. The Army is buying kits for each aircraft, which include the modification hardware, wiring harness, cables necessary to install and interface the ATIRCM/CMWS to each platform. The Army plans to buy 1,710 ATIRCM/CMWS systems and 3,571 kits to use for aircraft integration. As a result, the true unit procurement cost for each ATIRCM/CMWS system is more on the order of $2.8 million.

The current program baseline includes accelerated funding to procure additional ATIRCM/CMWS systems additional nonrecurring engineering driven by an increase in the number and types of platforms. The quantity of ATIRCM/CMWS systems was increased from 1,076 to 1,710 in June 2005. A new Army cost position has been established that reflects the impact of the CMWS full rate production decision, the increased quantities, and the schedule delays.

Agency Comments

The ATIRCM/CMWS program has been realigned to address Global War on Terrorism requirements and implement improvements. In response to a November 2003 memo from the Assistant Secretary of the Army to equip all Army helicopters in Iraq and Afghanistan with the most effective defensive systems, the program office proposed accelerating the CMWS portion of ATIRCM. To date, 506 installation kits and 214 CMWS's have been fielded. Full-rate production decision for CMWS required a separate Initial Operational Test and Evaluation, completed November 2005. CMWS full rate production decision is planned for February 2006.

The ATIRCM system experienced performance and reliability issues during October 2004 testing. The program has been rebaselined, allowing for improved performance, adding a multiband laser capability and increased ATIRCM system reliability. Full rate production is currently planned for fiscal year 2010. This rebaselined plan was presented and approved by the Army Acquisition Executive in December 2005.

B-2 Radar Modernization Program (B-2 RMP)

The Air Force's B-2 RMP is designed to modify the current radar system to resolve potential conflicts in frequency band usage. To comply with federal requirements, the frequency must be changed to a band where the B-2 will be designated as a primary user. The modified radar system is being designed to support the B-2 stealth bomber and its combination of stealth, range, payload, and near precision weapons delivery capabilities.

Source: U.S. Air Force, U.S. Edwards Air Force Base, California.

Concept	System development			Production			
Program start (10/02)	Development start (8/04)	Design review (5/05)	GAO review (1/06)	Low-rate decision (2/07)	Initial capability (1/08)	Full-rate decision (2/08)	Last procurement (2009)

Program Essentials

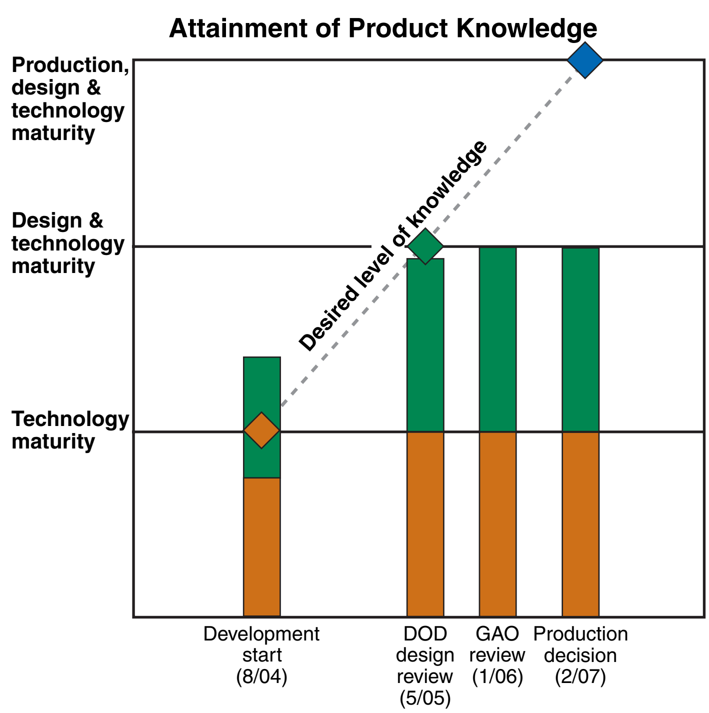
Prime contractor: Northrop Grumman
Program office: Dayton, Ohio
Funding needed to complete:
R&D: $464.6 million
Procurement: $508.5 million
Total funding: $973.2 million
Procurement quantity: 14

Program Performance (fiscal year 2006 dollars in millions)

	As of 08/2004	Latest 10/2005	Percent change
Research and development cost	$670.4	$635.2	-5.2
Procurement cost	$524.3	$508.5	-3.0
Total program cost	$1,194.8	$1,143.8	-4.3
Program unit cost	$56.893	$54.466	-4.3
Total quantities	21	21	0.0
Acquisition cycle time (months)	63	63	0.0

The total quantity of 21 units includes 14 to be bought with procurement funds and 7 to be bought with R&D funds. All 21 units will eventually be placed on operational B-2 aircraft.

Since our assessment of the B-2 RMP last year, the program successfully completed its design review in May 2005 with all four critical technologies considered mature. The program had released 85 percent of its design drawings by the design review and plans to have 100 percent released by the start of production. Program officials told us production maturity metrics will be formulated during development and these metrics may or may not include manufacturing process control data. The program plans to build seven radar units during development for pilot training with the B-2 wing prior to the planned completion of flight testing. Six of these units will later be modified and placed on B-2 aircraft. These units are necessary, but building them in development adds to the risk of later design changes because most of the radar flight testing will not occur until after these units are built.



B-2 RMP Program

Technology Maturity

All four B-2 RMP critical technologies were considered mature at the design review in May 2005. While the program entered development in August 2004 with two of these four critical technologies mature and two approaching maturity, the receiver/exciter for the electronic driver cards and aspects of the antenna designed to help keep the B-2's radar signature low, all four are now considered mature. The program expects these technologies to reach a slightly higher level of maturity at the start of production in 2007.

Design Stability

The program office completed its design readiness review in May 2005 and at that time had 85 percent of its drawings released to manufacturing. The program plans to have 100 percent of its drawings released by the start of production in 2007. The program, however, does not use the release of design drawings as a measure of design maturity but instead uses the successful completion of design events, such as subsystem design reviews, as its primary measure of design maturity.

Production Maturity

Production maturity metrics are planned to be formulated during development. These metrics, which may or may not include manufacturing process control data, are planned to be used as measures of progress toward production maturity during a production readiness review prior to the start of production in February 2007. The program is also involved in a proof-of-manufacturing effort to demonstrate that the transmit/receive modules can be built to specifications.

Other Program Issues

The program plans to build seven radar units during development and later modify six of these units for placement on operational B-2 aircraft. The Air Force needs these radar units for air crew training and proficiency operations. Even though these units are necessary, building them early in development adds risk because most of the radar flight-test activity will not occur until after these units are built.

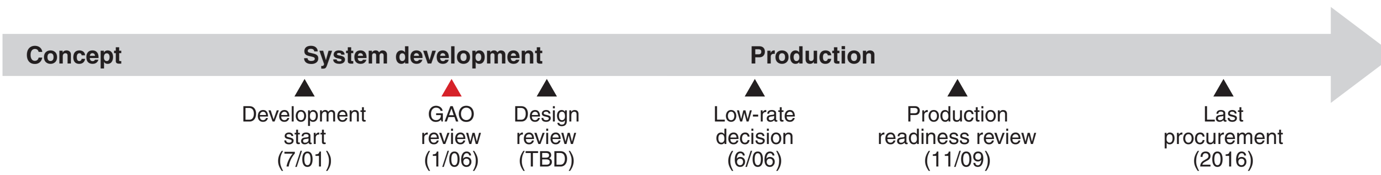
Agency Comments

The Air Force concurred with this assessment.

C-130 Avionics Modernization Program (C-130 AMP)

The Air Force's C-130 AMP standardizes the cockpit configurations and avionics for 14 different mission designs of the C-130 fleet. It consolidates and installs the mandated DOD Navigation/Safety modifications, the Global Air Traffic Management systems, and the C-130 broad area review requirements. It also incorporates other reliability, maintainability, and sustainability upgrades and provides increased situational awareness capabilities and reduces susceptibility of Special Operations aircraft to detection/interception.

Source: C-130 Avionics Modernization Program, System Program Office.



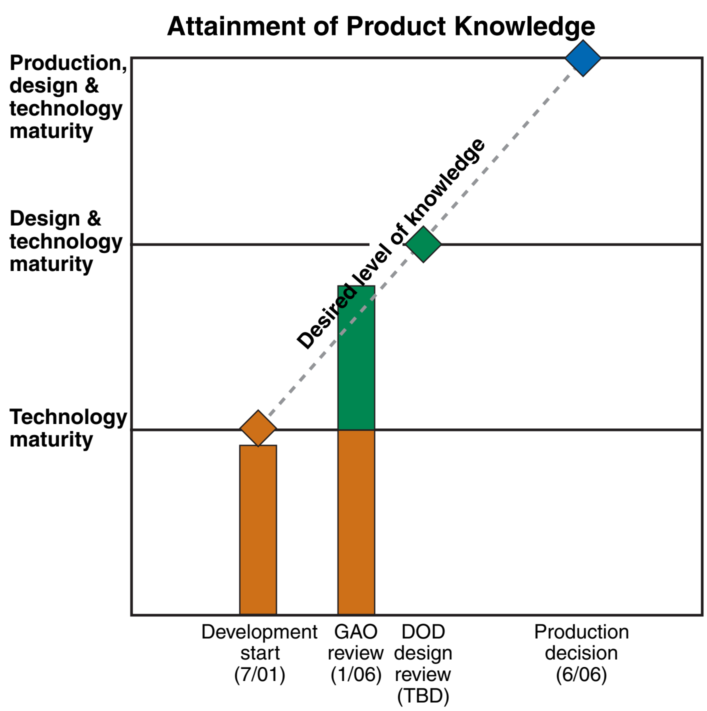
Program Essentials

Prime contractor: Boeing
Program office: Dayton, Ohio
Funding needed to complete:
R&D: $829.5 million
Procurement: $2,620.4 million
Total funding: $3,449.9 million
Procurement quantity: 454

Program Performance (fiscal year 2006 dollars in millions)

	As of 07/2001	Latest 08/2005	Percent change
Research and development cost	$688.8	$1,529.2	122.0
Procurement cost	$2,981.7	$2,564.9	-14.0
Total program cost	$3,670.5	$4,094.1	11.5
Program unit cost	$7.072	$8.805	24.5
Total quantities	519	465	-10.4
Acquisition cycle time (months)	TBD	TBD	TBD

The C-130 AMP is utilizing commercial and modified off-the-shelf technologies, and it entered system development with five of its six critical technologies mature. The final technology reached maturity in 2005 through a series of demonstration flights. Program officials plan to release 90 percent of engineering drawings by the design review and have made progress toward that goal. As of December 2005, 100 percent of required drawings for Combat Delivery First Flight had been released. Program delays have resulted from funding cuts, and sustained development contract protests required a portion of the contract to be recompeted. The August 2005 design review has been postponed indefinitely, and the low rate initial production decision has been delayed until June 2006. These dates may change again after program restructuring is completed.



C-130 AMP Program

Technology Maturity
All of the C-130 AMP's six critical technologies are fully mature, as the program is primarily utilizing proven commercial and modified off-the-shelf technology for all AMP capabilities. A program official stated that the last immature critical technology, Terrain Following and Terrain Avoidance radar, reached full maturity in 2005 by meeting the key requirement of operability at 250 feet during demonstration flights.

Design Stability
As of December 2005, the program office had released 100 percent of required drawings for Combat Delivery First Flight. According to the Air Force, due to program restructuring, the Combat Talon critical design review was postponed indefinitely, and a new review date will be established under the current replan effort.

The modernization effort is divided into a number of capability spirals due to the various aircraft designs. The first spiral will outfit C-130 aircraft with core capabilities and an integrated defensive system. Special Operations C-130 aircraft will be outfitted first, and future spirals are planned for these aircraft because they require additional, and unique, defensive systems integration and enhanced situational awareness.

Other Program Issues
Since GAO's last review of the C-130 AMP, the program office has postponed the design readiness review indefinitely, pushed back the low-rate initial production 4 months, and delayed the production readiness review 18 months.

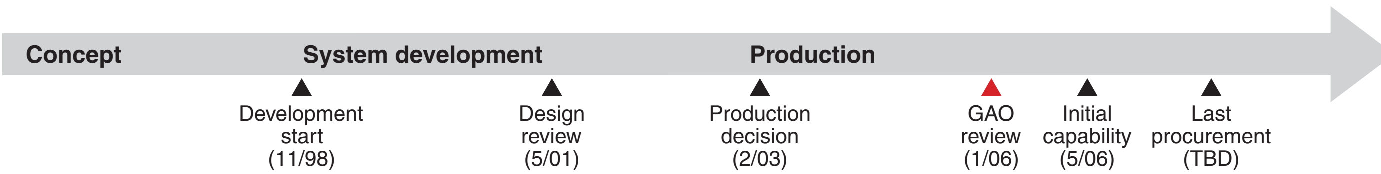
Funding reductions in fiscal years 2003 and 2004 delayed the development program and contributed to the rescheduling of program milestones and the rebaselining of the program. In addition, sustained protests associated with the C-130 AMP development contract awarded in 2001 required that a portion of the contract be recompeted.

Agency Comments
The Air Force provided technical comments to a draft of this assessment, which were incorporated where appropriate.

C-5 Avionics Modernization Program (C-5 AMP)

The Air Force's C-5 AMP is the first of two major upgrades for the C-5 to improve the mission capability rate, transport capabilities and reduce ownership costs. The AMP implements Global Air Traffic Management, navigation and safety equipment, modern digital equipment, and an all-weather flight control system. The second major upgrade, the C-5 Reliability Enhancement and Reengining Program (RERP), replaces the engines and modifies the electrical, fuel, and hydraulic systems. We assessed the C-5 AMP.

Source: Lockheed-Martin Aeronautics Company.



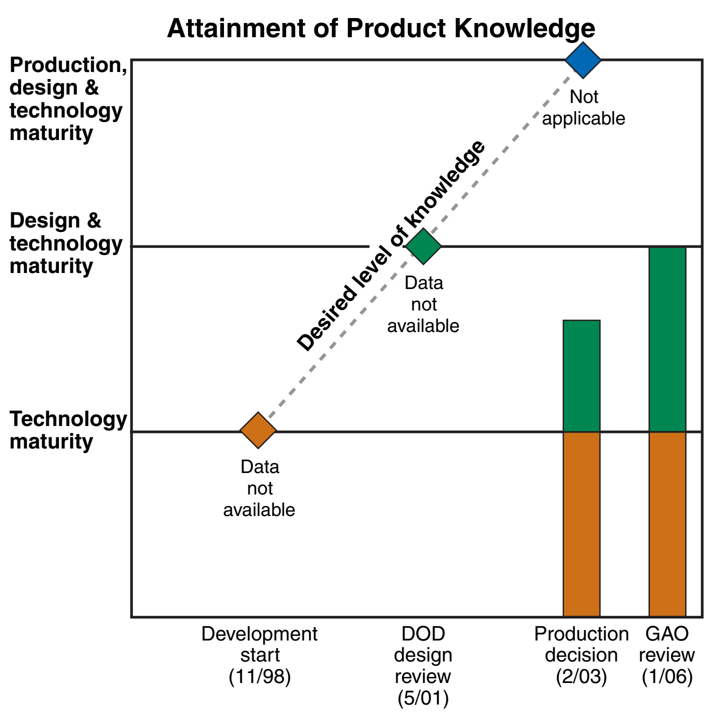
Program Essentials

Prime contractor: Lockheed Martin
Program office: Dayton, Ohio
Funding needed to complete:
- R&D: $0.0 million
- Procurement: $145.1 million
- Total funding: $145.1 million
- Procurement quantity: 12

Program Performance (fiscal year 2006 dollars in millions)

	As of 11/1998	Latest 03/2004	Percent change
Research and development cost	$356.4	$397.2	11.5
Procurement cost	$623.4	$463.3	-25.7
Total program cost	$979.7	$860.5	-12.2
Program unit cost	$7.776	$14.585	87.6
Total quantities	126	59	-53.2
Acquisition cycle time (months)	83	90	8.4

Since our assessment of the C-5 AMP last year, the program completed developmental test and evaluation in August 2005, 10 months later than planned. The program's technologies and design are considered mature as they are relying on commercial-off-the-shelf technologies that are installed in other commercial and military aircraft. The main challenge to the program has been the development and integration of software--to which the schedule delay as well as a $23 million cost overrun has been attributed. The Air Force plans to modify 59 of the 112 C-5 aircraft. The Air Force is also seeking funding to modify the remaining 53 C-5s; however, that decision will not be made until the Air Force determines the correct mix of C-5 and C-17 aircraft needed to meet DOD's airlift needs. If the Air Force decides to use the C-17s, it may not upgrade some, or all, of the remaining 53 C-5s.



C-5 AMP Program

Technology Maturity

We did not assess the C-5 AMP's critical technologies because the program used commercial technologies that are considered mature. Program officials stated that those technologies are in use on other aircraft and that they have not significantly changed in form, fit, or function. For example, the new computer processors are being used in the Boeing 777, 717, other commercial aircraft, the KC-10, and a Navy reconnaissance aircraft.

Design Stability

Last year we reported that the C-5 AMP had released 100 percent of their drawings; however, due to modifications in the design an additional 270 drawings were added. As a result, the program had completed only 54 percent of the total number of drawings for the system by the time of the production decision. The program now reports that the contractor has released all of the drawings for the AMP. In addition, seven major subsystem-level design reviews were completed along with integration activities. Demonstration of these activities were completed during developmental test and evaluation, which started in December 2002 and was completed in August 2005.

Production Maturity

We could not assess the production maturity because most components are readily available as commercial-off-the-shelf items. This equipment is being used on other military and commercial aircraft. In addition, the C-5 AMP is incorporating many other off-the-shelf systems and equipment, such as the embedded global positioning system, the inertial navigation system, and the multifunction control and display units. To ensure production maturity, the program office is collecting data regarding modification kit availability and the installation schedules.

Other Program Issues

Over the past year, the AMP program ran into significant problems while trying to complete software development that have impacted the cost and schedule of the program. Most notably, a software build was added to fix problems with AMP integration, flight management system stability and system diagnostics. The added build caused a $23 million cost overrun, which was paid for by shifting funds from the RERP program, and extended developmental testing to 10 months. The program office acknowledged that an another software build may be added, depending on the results of operational testing that is now scheduled to be completed in July 2006.

Last year we reported that the Air Force was conducting mobility studies to determine the correct mix of C-5 and C-17 aircraft it would need in the future. This decision has not been made yet. In the meantime, the program office is continuing its plan to provide AMP modifications for 59 of the aircraft while all 112 aircraft are projected to go through the RERP program. If all 112 aircraft are needed and do go through the RERP program, then the Air Force will need to request additional money to fund AMP modifications for the remaining 53 aircraft.

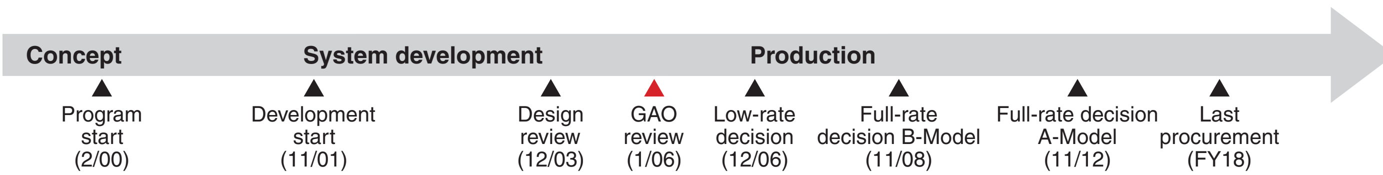
Agency Comments

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

C-5 Reliability Enhancement and Reengining Program (C-5 RERP)

The Air Force's C-5 RERP is one of two major upgrades for the C-5. RERP is designed to enhance the reliability, maintainability, and availability of the C-5 through engine replacement and modifications to subsystems, i.e. electrical and fuel, while the C-5 Avionics Modernization Program (AMP) is designed to enhance the avionics. The upgrades are part of a two-phased modernization effort to improve the mission capability rate, performance, and transport throughput capabilities and reduce total ownership costs. We assessed the C-5 RERP.

Source: Lockheed-Martin Aeronautics Company.



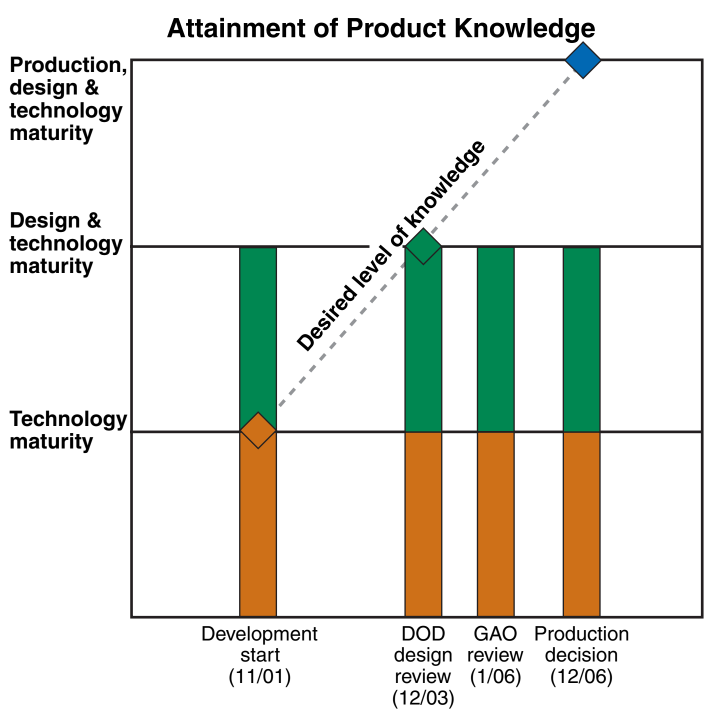
Program Essentials

Prime contractor: Lockheed Martin
Program office: Dayton, Ohio
Funding needed to complete:
R&D: $417.3 million
Procurement: $8,150.3 million
Total funding: $8,571.1 million
Procurement quantity: 109

Program Performance (fiscal year 2006 dollars in millions)

	As of 11/2001	Latest 12/2004	Percent change
Research and development cost	$1,556.6	$1,358.1	-12.8
Procurement cost	$8,126.2	$8,150.3	0.3
Total program cost	$9,686.2	$9,511.9	-1.8
Program unit cost	$76.875	$84.928	10.5
Total quantities	126	112	-11.1
Acquisition cycle time (months)	100	125	25.0

The RERP is utilizing demonstrated commercial off-the-shelf components that require little or no modification. The program ensured that its technologies and design were stable at critical points in development. The program, which is currently in system development and demonstration, plans to enter low-rate production in December 2006. However, since last year the program has experienced a 9-month schedule delay due to multiple issues, such as a pylon redesign, and has been subject to almost $50 million in budget cuts that further increases schedule risk. The C-5 RERP program is also dependent on the number of aircraft approved to undergo the C-5 AMP modernization program. Until additional aircraft are approved for the AMP, it is uncertain how many aircraft will undergo the RERP.



C-5 RERP Program

Technology Maturity

The C-5 RERP's technologies are mature based on an independent technology readiness assessment conducted in October 2001. New engines account for 64 percent of the expected improvement in mission capability rate for the aircraft. The new engines are commercial jet engines currently being used on numerous aircraft. According to the Air Force technology assessment, these engines have over 238 million flying hours of use.

Design Stability

The C-5 RERP's design is undergoing changes due to a necessary redesign of the pylon/thrust reverser to address overweight conditions and safety concerns for the engine mount area. According to program officials, the redesign has contributed 4 months to the overall 9 month schedule delay of the program. Prior to this redesign, 98 percent of the design drawings were complete. It is unclear what effect the latest redesign will have on the completed drawings. According to the program office, the seven major subsystem level design reviews were completed before the December 2003 system-level design review.

The program is taking advantage of AMP developed products and lessons learned in the C-5 RERP to reduce the risk of potential schedule slips associated with software development and integration. For example, according to program officials, some of the baseline software and systems integration facilities that were developed for C-5 AMP can be reused for RERP activities.

Production Maturity

We did not assess the C-5 RERP's production maturity because the Air Force is buying commercially available items. However, we expect that production maturity would be at a high level because the engines have been commercially available for many years.

Other Program Issues

The program has experienced a 9-month schedule delay since last year due to multiple issues including, pylon weight and redesign, asymmetric thrust reverser development problems, C-5 AMP delays, and wing rib web structure design and manufacture. The 9-month delay has cost the program an additional $45 million. In addition, recent budget reductions of almost $50 million are increasing the schedule risk of the program. Almost half of this money was shifted to the C-5 AMP to help that program complete software development activities. The remaining funds were cut by OSD because it appeared the program was under executing its funds. These cuts, along with the pylon development problems mentioned earlier, have forced the delay of the trainer program until fiscal year 2008. Program officials are also considering aggressive steps, such as hiring additional workers and using multiple shifts, to address potential schedule increases.

RERP officials are currently monitoring negotiations between DOD and General Electric to bring General Electric into full compliance with the Berry Amendment, which requires certain metals used in military systems to be purchased from domestic sources. According to Air Force officials, General Electric expects to be in full compliance with the Berry Ammendment by January 2007, without impact to C-5 RERP.

The program is still waiting on the results of a mobility study to determine the mix of C-5 and C-17 aircraft the Air Force plans to use in the future. Until that decision is made, the Air Force is continuing its plan to re-engine all 112 C-5 aircraft. Before that can be done, however, all 112 will need to complete the AMP upgrade. Yet, the Air Force has only provided funding for 59 of the aircraft to receive the AMP upgrade at this time.

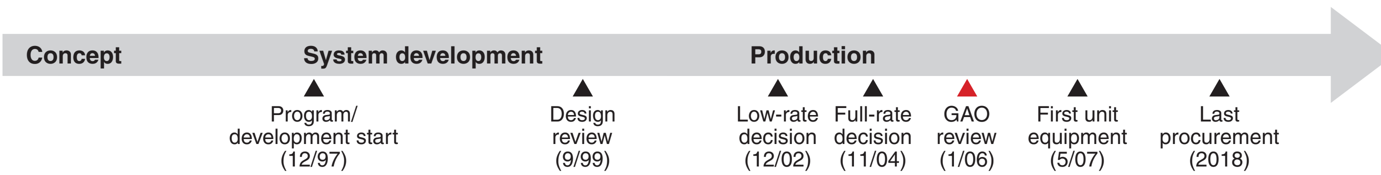
Agency Comments

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

CH-47F

The Army's CH-47F heavy lift helicopter is intended to provide transportation for tactical vehicles, artillery, engineer equipment, personnel, and logistical support equipment. It is also expected to operate in both day and night. The program goal is to enhance performance and extend the useful life of the CH-47 as well as produce new helicopters. This effort includes installing a digitized cockpit, rebuilding the airframe, and reducing aircraft vibration.

Source: Boeing Helicopters.



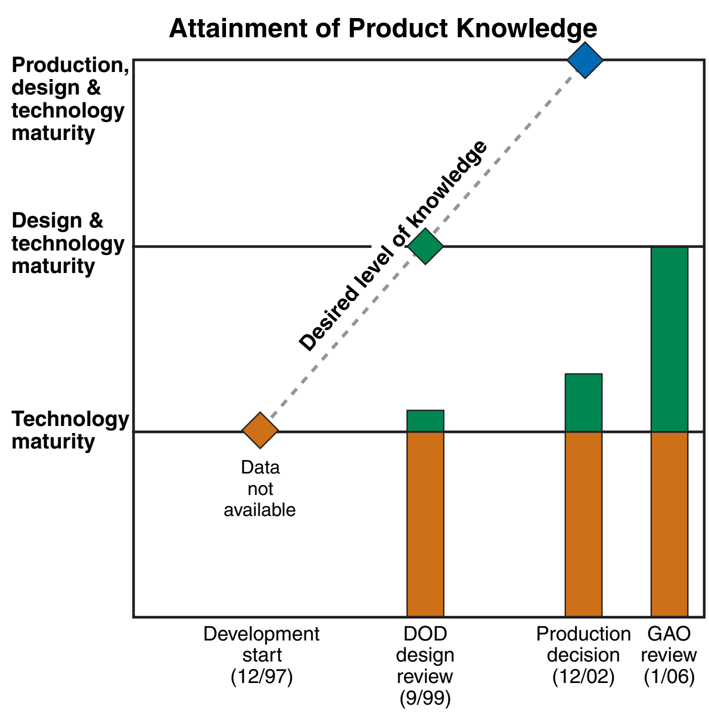
Program Essentials

Prime contractor: Boeing Helicopters
Program office: Huntsville, Ala.
Funding needed to complete:
R&D: $7.8 million
Procurement: $9,064.4 million
Total funding: $9,072.1 million
Procurement quantity: 454

Program Performance (fiscal year 2006 dollars in millions)

	As of 05/1998	Latest 12/2004	Percent change
Research and development cost	$154.5	$185.4	20.0
Procurement cost	$2,705.2	$10,647.5	293.6
Total program cost	$2,859.6	$10,832.9	278.8
Program unit cost	$9.469	$21.158	123.4
Total quantities	302	512	69.5
Acquisition cycle time (months)	82	114	39.0

The CH-47F technologies appear mature and the design stable, with 100 percent of the engineering drawings released for manufacturing. CH-47F production maturity could not be assessed as the program is not collecting statistical process control data on key manufacturing processes. Program officials believe that CH-47F production is low risk because no new technology is being inserted into the aircraft, two prototypes have been produced, and the production process was demonstrated during the delivery of one low-rate initial production aircraft. Since our last assessment, the CH-47F program entered full rate production and increased quantities from 339 to 512 aircraft. Because the increase in quantities includes 55 new build helicopters, program unit cost increased approximately 12 percent over what we reported last year.



CH-47F Program

Technology Maturity

We did not assess technology maturity or determine the number of critical technologies in detail. The CH-47F is a modification of the existing CH-47D helicopter. Program officials believe that all critical technologies are mature and have been demonstrated prior to integration into the CH-47F development program.

Design Stability

The Army entered full rate production in November 2004, with 100 percent of the drawings released to manufacturing. However, the number of drawings completed increased substantially since the start of low rate production. As a result, the level of maturity achieved at design review was only 11 percent and at low rate production was 31 percent. The majority of the new drawings were instituted to correct wire routing and installation on the aircraft. Accordingly, the program office believed the total number of drawings could not be determined until after the first prototype was delivered.

Production Maturity

We did not assess production maturity because the CH-47F program does not collect statistical process control data on its production of helicopters. The program office relies on inspections as its means to ensure acceptable production results.

According to the program office, the CH-47 production is low risk because two prototypes have been produced during development and the Army recently took delivery of its first low-rate initial production aircraft. Further, the program reported that during low-rate production, it made significant advances in the refinement of CH-47 production processes. Advances include the implementation of the automated management execution system and the introduction of laser tracking to identify key mounting points. These enhancements are geared toward improving the manufacturing learning curve. However, the program office acknowledges that the program will lose some of the learning benefits during the anticipated break in production of the CH-47F in favor of producing more MG-47 special operations configuration helicopters during the next lot of production.

Other Program Issues

In November 2004, the Army Acquisition Executive approved the revised program acquisition strategy and approved the start of full rate production. This acquisition strategy includes service life extension upgrades for the CH-47D fleet and a number of new-build aircraft to meet operational fleet requirements. Included in the new baseline is a revised acquisition objective quantity of 512 upgraded aircraft as opposed to the 339 previously reported. Of the larger quantity, 2 are developmental; 55 will be new build CH-47Fs; 58 will be remanufactured in the special operations configuration; and 397 remanufactured into CH-47Fs to replace the current CH-47Ds. Because new builds, as opposed to only remanufactured helicopters, have been included in the acquisition plan, unit cost increased 12 percent over what we reported last year.

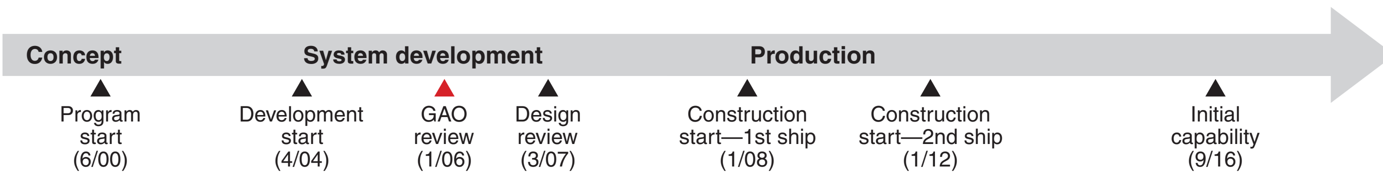
Agency Comments

In commenting on a draft of this assessment, the Army concurred with the information presented in this report. One technical comment was provided, which was incorporated as appropriate.

Future Aircraft Carrier CVN-21

The Navy's CVN-21 class is the successor to the Nimitz-class aircraft carrier and includes a number of advanced technologies in propulsion, aircraft launch and recovery, weapons handling, and survivability. These technologies are to allow for increased sortie rates and decreased manning rates as compared to existing systems. Many of the technologies were intended for the second ship in the class, but they were accelerated into the first ship in a December 2002 restructuring of the program.

Source: CVN-21 Program Office.



Program Essentials

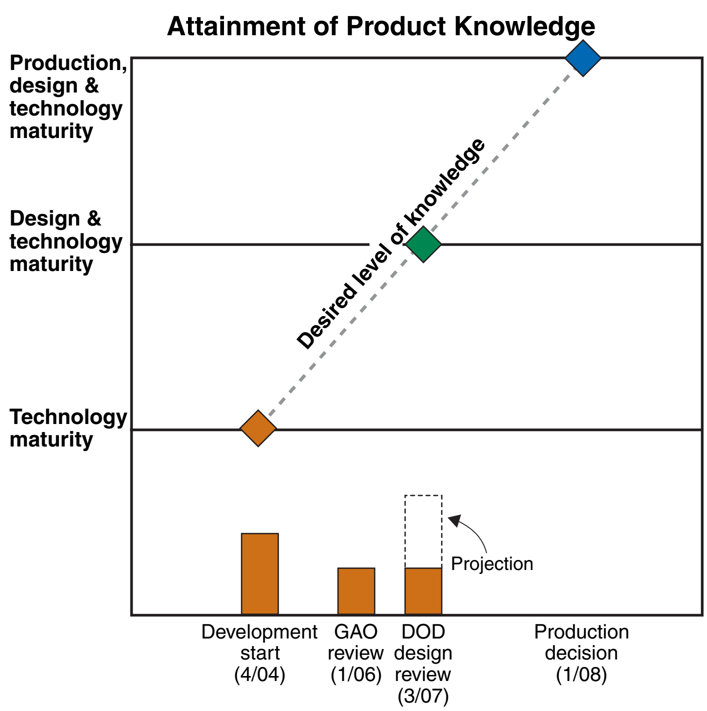
Prime contractor: Northrop Grumman Newport News
Program office: Washington, D.C.
Funding needed to complete:
- R&D: $2,370.0 million
- Procurement: $23,457.7 million
- Total funding: $25,827.7 million
- Procurement quantity: 3

Program Performance (fiscal year 2006 dollars in millions)

	As of 04/2004	Latest 08/2005	Percent change
Research and development cost	$4,266.5	$4,263.3	-0.1
Procurement cost	$27,332.3	$25,689.8	-6.0
Total program cost	$31,598.8	$29,953.1	-5.2
Program unit cost	$10,532.937	$9,984.366	-5.2
Total quantities	3	3	0.0
Acquisition cycle time (months)	183	195	6.6

Costs decreased due to adjustments in inflation figures and refinements to third ship estimates.

The CVN-21 entered system development in April 2004 with few of its critical technologies fully mature. This is due in part to DOD's decision to accelerate the installation of a number of technologies from the second ship to the first. Program officials state that the extended construction and design period allows further time for development. They have established a risk reduction strategy that includes decision points for each technology's inclusion based on a demonstrated maturity level. Fallback technologies exist for 11 of 18 total critical technologies, but their use would lead to drawbacks, such as performance shortfalls and/or an increase in manpower requirements. The program has reported a 1-year schedule slip based on decisions to balance ship construction in the President's fiscal year 2006 budget. Program officials expect to meet their design review date, currently set for March 2007.



CVN-21 Program

Technology Maturity

There are currently a total of 18 CVN-21 critical technologies, of which 3 are presently mature and 3 are approaching maturity. The remaining 12 are at lower levels of maturity. The Navy expects that 14 of the 18 total technologies will be mature or close to mature by the design review in fiscal year 2007, and they expect all but 1 technology to be near maturity by production start in 2008. Program officials originally reported 16 critical technologies at development start. However, one technology was re-defined into two, more specific technologies and another was added since that time.

Six of the critical technologies are being developed by programs other than CVN-21. Progress in those programs could affect the CVN-21 timeline. Those technologies are the Advanced Arresting Gear, Evolved Sea Sparrow Missile, Joint Precision Approach and Landing System, Multi-Function Radar, Volume Search Radar, and the Advance Weapons Information Management System/Aviation Data Management and Control System. This last technology was redefined after development start. In the case of four technologies the program has mature alternate systems as backup technologies. Program officials stated that no backup is feasible for either Volume Search Radar or Multi-Function Radar without major ship redesign.

Two technologies modified since development start are also not mature. The Shipboard Weapons Loader is a self-propelled unit to decrease the time required to load weapons onto aircraft. The other technology is Smart Stores, which is a software-based system to automate CVN-21's inventory and material asset management capabilities. The Navy's primary risks identified for this technology center on successful integration with planned ship systems. The Navy has identified backup technologies for each of these technologies.

Only one critical technology, the 1,100-ton air conditioning plants, is not planned to be near maturity by construction start. Program officials believe the plants will reach mature levels shortly after the start of construction. Risks associated with the plants are considered low by officials since the technology being used is derived from commercial applications and enhancements leveraging experience from plants found on other US Navy ships.

Design Stability

The CVN-21 program is currently planning a design review date for March 2007. Rather than measuring design stability by percentage of engineering drawings completed, the program uses an alternative metric that measures earned hours completed in product model development. As a result we could not assess the ship's design stability.

Other Program Issues

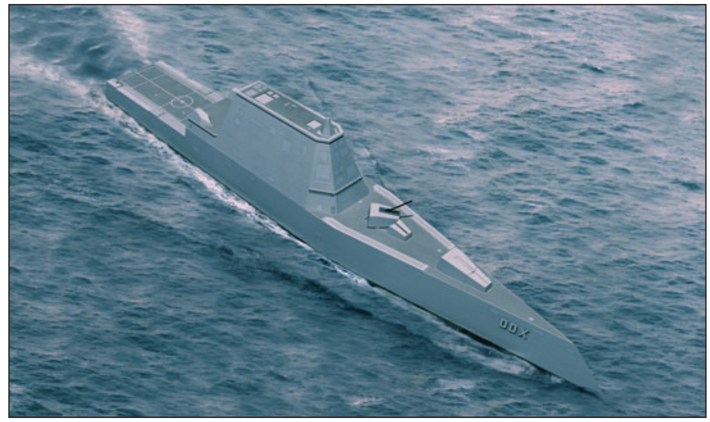
The program has delayed delivery of both the first and second ship by adding one year to the development schedule. According to program officials, the Navy made this decision with the intent to balance ship construction dollars in the President's fiscal year 2006 budget. Research and development funds were added to the program to bridge the additional year, which allows additional time and funding to mature technologies in the program. The one year shift does create an additional gap, where the Navy will have to operate with only 11 carriers, between de-commissioning of the USS Enterprise aircraft carrier and delivery of the first CVN-21 to the fleet.

Agency Comments

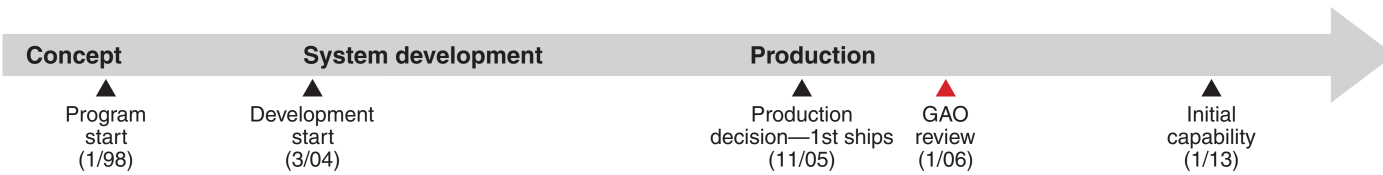
In commenting on a draft of this assessment, the Navy emphasized that, based on product model development progress, the CVN-21 program's overall design was 44 percent complete as of November 2005 and that the program is on schedule to support the construction of the lead ship. In addition, the department said that although there was a one year slip based on decisions to balance ship construction in the President's fiscal year 2006 budget, technology development efforts were unaffected and remain on track.

DD(X) Destroyer

The Navy's DD(X) destroyer is a multimission surface ship designed to provide advanced land attack capability in support of forces ashore and contribute to U.S. military dominance in littoral operations. The program recently completed the system design phase and was authorized to begin detail design and construction of the lead ships in November 2005. The program will continue to mature its technologies and design as it approaches construction.



Source: DD(X) Program Office (PMS 500).



Program Essentials

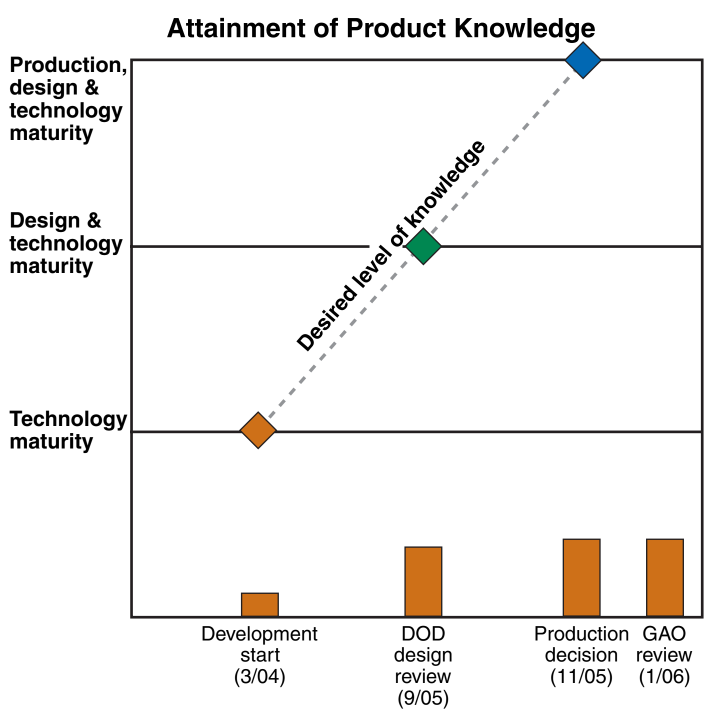
Prime contractor: BAE Systems, Bath Iron Works, Northrop Grumman Ship Systems, Raytheon
Program office: Washington, D.C.
Funding needed to complete:
R&D: $3,241.7 million
Procurement: $0.0 million
Total funding: $3,241.7 million
Procurement quantity: 0

Program Performance (fiscal year 2006 dollars in millions)

	As of 01/1998	Latest 09/2005	Percent change
Research and development cost	$2,023.8	$8,111.5	300.8
Procurement cost	$0.0	$0.0	0.0
Total program cost	$2,023.8	$8,111.5	300.8
Program unit cost	NA	NA	NA
Total quantities	0	0	0.0
Acquisition cycle time (months)	128	180	40.6

Costs increased due to changes in cost estimating, additional technology development, and a program restructuring.

Since last year's assessment, the program completed demonstrations of a number of its 12 critical technologies. One of the technologies was fully mature by the November 2005 production decision. Eight technologies were demonstrated in a relevant environment and are near full maturity. Some of these technologies will not be fully mature until after installation on the first ship as testing in an operational environment is not considered feasible. The integrated deckhouse, ship computing system, and volume search radar are at lower levels of maturity, having completed component level demonstrations. The Navy approved the system design to proceed into the next phase, but a number of risks remain in both design and technology that could lead to changes.



DD(X) Program

Technology Maturity

At the November 2005 production decision, one of 12 critical technologies for DD(X) was fully mature. While completion of tests in 2005 advanced the maturity of technologies, development continues as the program proceeds with detail design. Eight technologies, the advanced gun system and its projectile, autonomic fire suppression, hull form, infrared suppression, integrated power system, multifunction radar, and peripheral vertical launch system are short of full maturity but have been demonstrated in a relevant environment. Program officials state that the undersea warfare system is fully mature, based on the use of mature components. However, the components will not be integrated and tested together until after ship installation. Due to practical limitations some of these technologies, the advanced gun system and its projectile, hull form, and infrared suppression, will not be fully demonstrated until after installation on the lead ship.

The integrated deckhouse, volume search radar, and ship computing system are at lower levels of maturity. The program tested a physical model of the deckhouse for stealth requirements and placement of apertures to minimize interference, but with only a portion of the apertures expected. Analysis of deckhouse resilience to fire and shock has been completed, and will be tested during detail design. The volume search radar will require additional development to increase performance, which may aggravate an already aggressive schedule. Software development has been progressing as planned, although about three-quarters of the effort remains.

Design Stability

The metric for design maturity used in other programs does not apply to DD(X), and therefore the program was not assessed according to this metric. Instead the program assesses design stability by reviewing design artifacts, which include items like system drawings, ship specifications, and major equipment lists. The program office states that all 2010 design artifacts are complete, though some may be altered as systems continue to mature or are changed to meet cost reduction goals.

On September 14, 2005 the Navy completed the critical design review of DD(X) and approved the start of detail design. Risk remains in the system design due to issues in the power system, deckhouse, and hull form. The concern with the power system is ensuring the design meets limits on space and weight. As this system is needed early in construction, it could have an impact on schedule if not resolved quickly. A number of systems in the deckhouse, including the volume search radar and electronic warfare system, are still in development and design of the deckhouse could be affected if they exceed margins for weight and space. Furthermore, due to the hull form's unique design, it has reduced stability in very severe weather conditions. Program officials state they can reduce this risk through guidance that helps the crew avoid these conditions. Model testing for heavy sea conditions also revealed some areas which may require strengthened structure, and program officials believe this can be corrected.

Agency Comments

The Navy stated that the design, development and testing of critical technologies mitigated the significant technical risks prior to critical design review. The DD(X) ship design remained stable throughout critical technology testing, successfully incorporating all necessary component modifications and entering detail design with adequate weight margin. A comprehensive test program will address all remaining risk areas described in the report.

The Navy further noted that given the unique nature of shipbuilding, with detail design and construction spread over 5 years, comparing DD(X) technology readiness levels to the GAO-developed best practices is not valid. DD(X) technology readiness levels met current acquisition policy guidance in support of the decision to proceed into system development in November 2005.

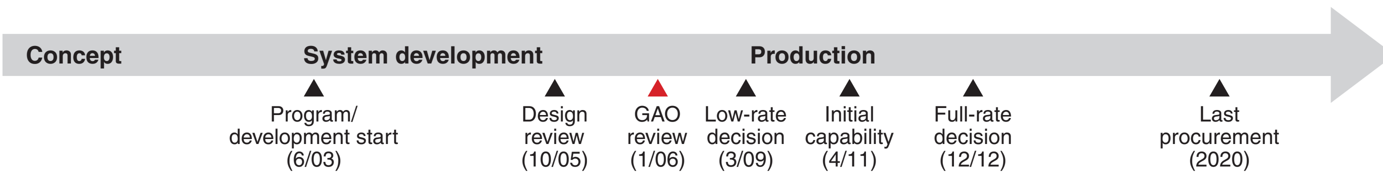
GAO Response

Our approach is valid because our work has shown that technological unknowns discovered late in development lead to cost increases and schedule delays. Some of the technologies still under development for DD(X) could have major impact on ship design and construction schedules.

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 E-2D AHE is designed to improve battle space target detection and situational awareness, especially in littoral areas; support Theater Air and Missile Defense operations; and improve operational availability.

Source: Program Executive Office, Tactical Aircraft Programs (PMA-231).



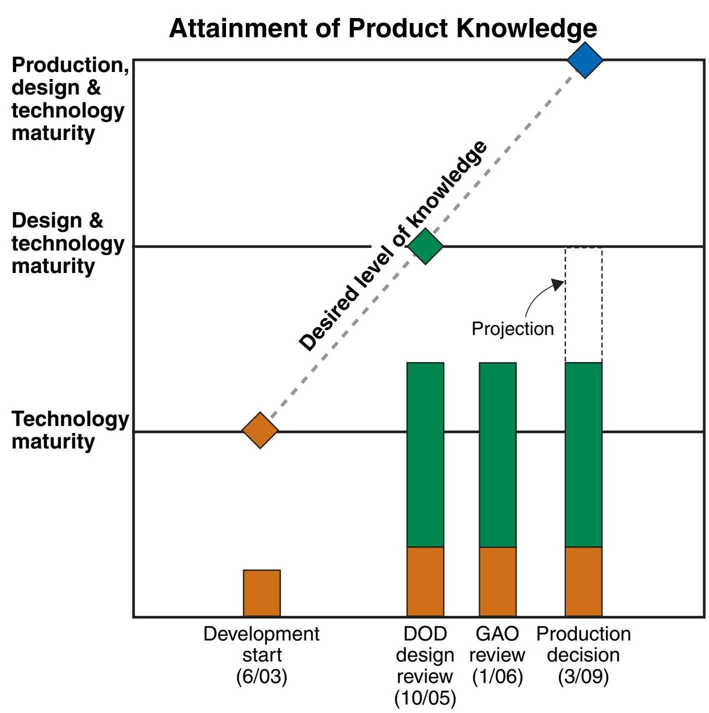
Program Essentials

Prime contractor: Northrop-Grumman Corp.
Program office: Patuxent River, Md.
Funding needed to complete:
- R&D: $2,464.8 million
- Procurement: $9,695.1 million
- Total funding: $12,159.9 million
- Procurement quantity: 69

Program Performance (fiscal year 2006 dollars in millions)

	As of 06/2003	Latest 12/2004	Percent change
Research and development cost	$3,411.2	$3,588.6	5.2
Procurement cost	$9,691.3	$9,695.1	0.0
Total program cost	$13,102.5	$13,283.6	1.4
Program unit cost	$174.700	$177.115	1.4
Total quantities	75	75	0.0
Acquisition cycle time (months)	95	94	-1.1

The E-2D AHE program entered system development in June 2003 without demonstrating that its four critical technologies had reached full maturity. Since that time, one of the program's four critical technologies has reached full maturity. The program expects the remaining three critical technologies to mature before the production decision in March 2009. While more mature backup technologies exist for the three critical technologies, use of the backup technologies would result in degraded system performance or reduced ability to accomodate future system growth. The design met best practice standards at the time of design review in October 2005. However, until all the technologies are mature, the potential for design changes remains. We could not assess production maturity because the program does not plan to use statistical process controls.



E-2D AHE Program

Technology Maturity

One of the E-2D AHE's four critical technologies (the space time adaptive processing algorithms and associated processor) is mature. The program expects the remaining technologies (the rotodome antenna, a silicon carbide-based transistor for the power amplifier to support UHF radio operations, and the multichannel rotary coupler for the antenna) to be fully mature before the start of production in March 2009.

More mature backup technologies exist for the three technologies (the rotodome antenna, the silicon carbide-based transistor, and the multichannel rotary coupler) and were flown on a larger test platform in 2002 and 2003. However, use of the backup technologies would result in degraded system performance or reduced ability to accomodate future system growth due to size and weight constraints. The next AHE technology readiness assessment is to be performed prior to the production decision in fiscal year 2009, and the program office anticipates that the critical technologies will be mature at that time.

Design Stability

The program had completed 90 percent of its engineering drawings at the Critical Design Review, which was completed on October 21, 2005. Program officials project that they will have 100 percent completed by the planned start of production in March 2009. However, the technology maturation process may lead to more design changes.

Production Maturity

The program expects a low-rate production decision in March 2009, but does not require the contractor to use statistical process controls to ensure its critical processes are producing high quality and reliable products. According to the program, the contractor assembles the components using manual, not automated, processes that are not conducive to statistical process control. The program relies on post-production data, such as defects per unit, to track variances and non-conformance. The program also conducts production assessment reviews every 6 months to assess the contractor's readiness for production. The program has updated the manufacturing processes that were established and used for the E-2C over the past 30 years. The program considers the single station joining tool; the installation of electrical, hydraulic and pneumatic lines; and the installation of the prime mission equipment all critical manufacturing processes.

The program is currently building the first two development aircraft. Accordng to the program office, there are no significant differences in the manufacturing processes for the development aircraft and the production aircraft.

Agency Comments

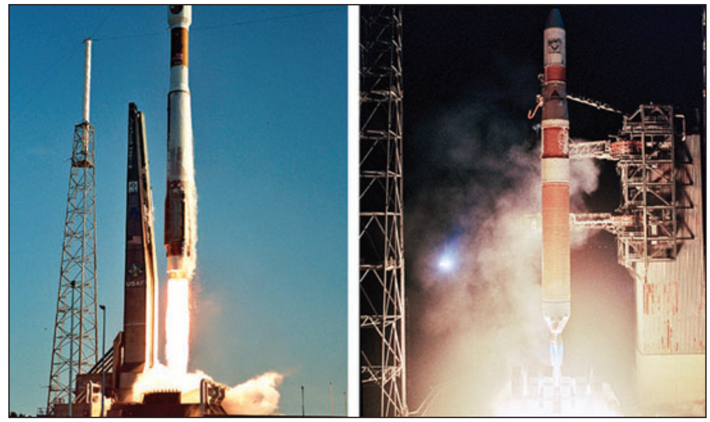
In commenting on a draft of this assessment, the Navy stated that the E-2D AHE program successfully executed all component and subsystem design reviews, culminating in the successful completion of the weapon system design review in October 2005. This review included a thorough evaluation of the four critical technologies and all program risks. According to the Navy, critical technologies do not represent a high risk to the AHE program at present.

Flight testing, which will include the four critical technologies, is planned to begin in the fourth quarter of fiscal year 2007. The test program expects to demonstrate the design maturity of all technologies and capabilities at that time. A Technology Readiness Assessment will be conducted prior to the low rate production decision.

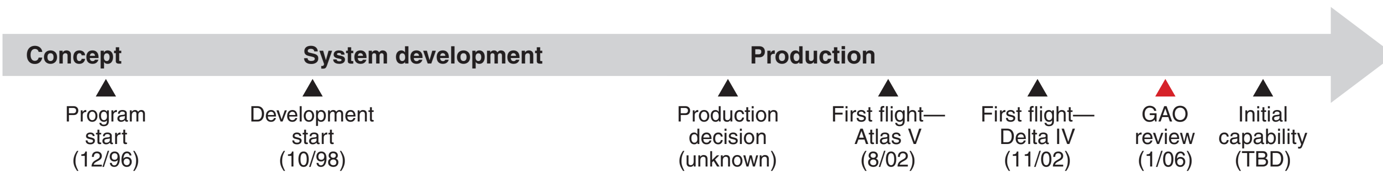
According to the Navy, integration of statistical process controls would require significant investment to update the E-2D aircraft manufacturing process. The Navy has elected not to make this investment due to the maturity and over 30 years of E-2 production.

Evolved Expendable Launch Vehicle (EELV) - Atlas V, Delta IV

The Air Force's EELV program acquires commercial satellite launch services from two competitive families of launch vehicles—Atlas V and Delta IV. Initiated as an industry partnership, the program's goal is to support and sustain assured access to space and reduce the life-cycle cost of space launches by at least 25 percent over previous systems while meeting the government's launch requirements. A number of variants are available depending on the lift capability necessary for each mission. We assessed both the Atlas V and Delta IV.



Source: (Left) © 2005 ILS/Lockheed Martin; (right) © 2003 The Boeing Company.



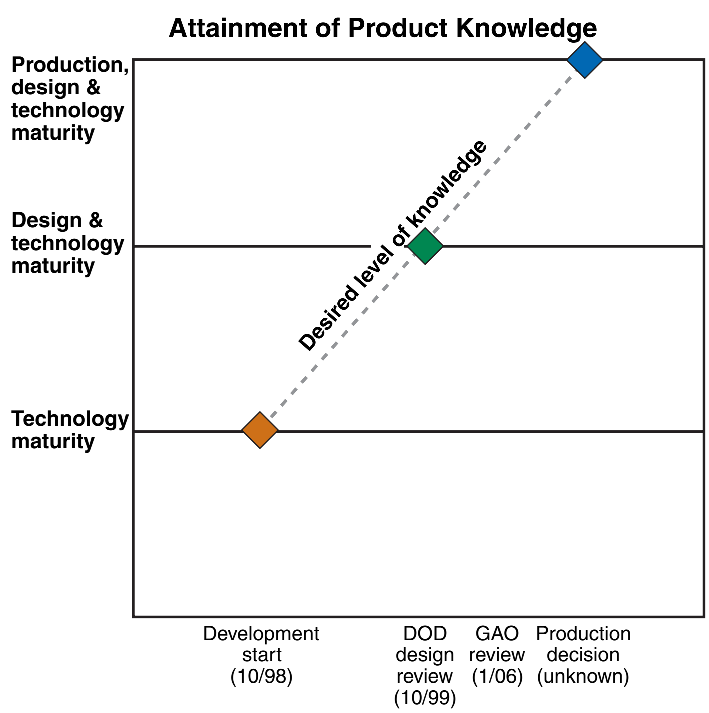
Program Essentials

Prime contractor: Boeing Launch Services, Lockheed Martin Space Systems
Program office: El Segundo, Calif.
Funding needed to complete:
- R&D: $43.4 million
- Procurement: $23,282.7 million
- Total funding: $23,326.2 million
- Procurement quantity: 118

Program Performance (fiscal year 2006 dollars in millions)

	As of 10/1998	Latest 08/2005	Percent change
Research and development cost	$1,581.9	$1,849.1	16.9
Procurement cost	$13,851.7	$26,130.5	88.6
Total program cost	$15,433.7	$27,979.6	81.3
Program unit cost	$85.269	$202.751	137.8
Total quantities	181	138	-23.8
Acquisition cycle time (months)	TBD	TBD	TBD

While the EELV program office has access to technology, design, and production maturity information, it does not collect this information because it is buying the launch service. To date, eleven successful launches have occurred—three government and eight commercial. A technical review was completed, and the program is implementing corrective actions to eliminate the cause of an earlier-than-expected engine shutdown during the Delta IV Heavy Lift Vehicle launch demonstration. The EELV program's total costs have increased due to a decline in the commercial launch market upon which the business case was based.



EELV Program

Technology Maturity

We could not assess the technology maturity of EELV because the Air Force has not formally contracted for information on technology maturity from its contractors.

Design Stability

We could not assess the design stability of EELV because the Air Force has not formally contracted for the information needed to conduct this assessment.

Production Maturity

We could not assess the production maturity of EELV because the Air Force has not formally contracted for information that would facilitate this assessment.

Other Program Issues

A decline in commercial launch demand for the EELV launch vehicles resulted in a cost increase of more than 25 percent over the program's objective and triggered a Nunn-McCurdy breach (10 U.S.C. 2433), that required DOD to certify in 2004 that the program is critical to national security and its cost estimates are reasonable. In conjunction with the certification, the Air Force revised its mission model to reflect a reduction of launch vehicles, conducted a study on assured access to space, and revised its acquisition strategy.

DOD continues to be the primary user of EELV launch services due to the decrease in commercial demand for launches--which has resulted in a reduction in the number of launch vehicles needed. An Air Force study on assured access to space addressed concerns about retaining both EELV launch providers given the limited number of launches. To ensure access to space with two distinct launch vehicles and address the decline in commercial launch demand, the government has agreed to share a level of risk with the launch providers through a new acquisition strategy. The new strategy provides for a contracting approach that supports each contractor's annual infrastructure through a launch capability contract and replaces price-based competition with an annual award of launch service contracts. In April 2005, the Air Force released a Request for Proposals for EELV Launch Services and EELV Launch Capabilities Contracts. The Air Force planned to award the contracts by October 2005. However, this has been delayed. Negotiations are currently ongoing for the launch capability contracts, and updated proposals are being submitted for the launch services contracts covering the anticipated fiscal year 2006 launch awards.

In August 2005, competitors Boeing and Lockheed Martin submitted a request to the Federal Trade Commission for an antitrust review to support a joint venture. This was withdrawn and resubmitted in September 2005. The Federal Trade Commission has requested additional information to support the review. The joint venture will combine their production, engineering, test, and launch operations for all U.S. government launch activity. Both contractors will share equally in the profits and costs of all government launches.

The EELV program is taking corrective action to address a problem with the liquid oxygen feed line that falsely indicated propellant depletion and resulted in an early engine shutdown of the first stage engine on the Delta IV during the Heavy Lift Vehicle Operational Launch Service Demonstration that occurred in December 2004.

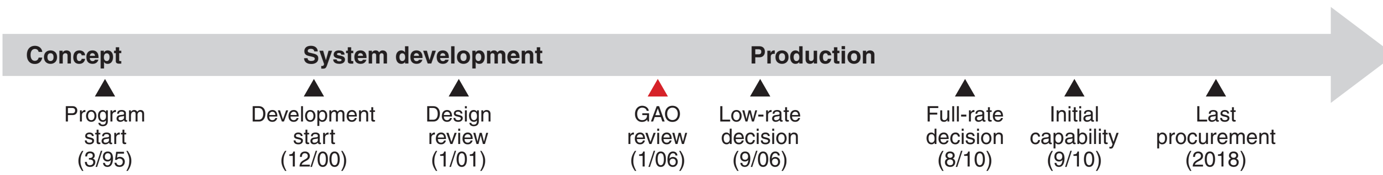
Agency Comments

In commenting on a draft of this assessment, the Air Force stated that it collects data for technology, design, and production maturity. However, the Air Force has not contracted for delivery of this data and therefore does not have authority to provide this information. Program officials also provided technical comments, which were incorporated where appropriate.

Expeditionary Fighting Vehicle (EFV)

The Marine Corps' EFV is designed to transport troops from ships offshore to their inland destinations at higher speeds and from longer distances than the system it is designed to replace, the Assault Amphibious Vehicle 7A1 (AAV-7A1). The EFV will have two variants—a troop carrier for 17 combat equipped Marines and 3 crew members and a command vehicle to manage combat operations in the field. We assessed both variants.

Source: General Dynamics Land Systems.



Program Essentials

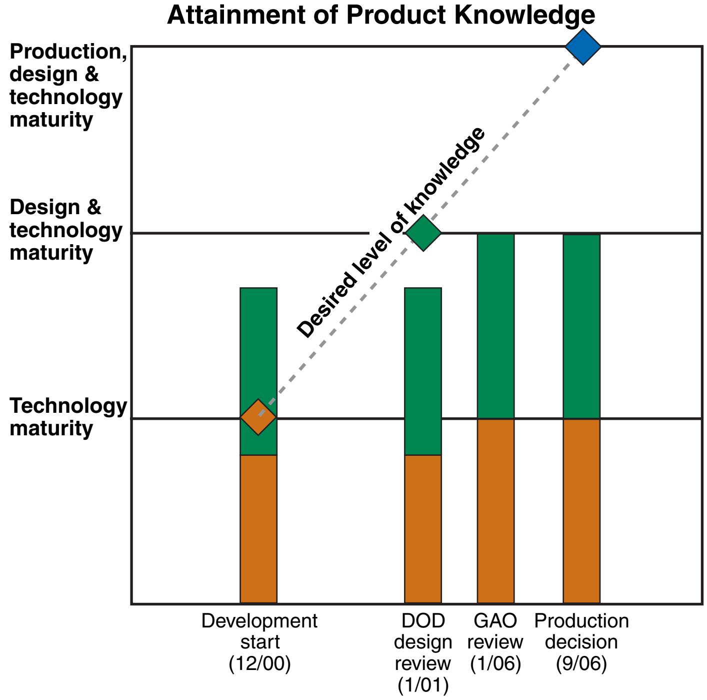
Prime contractor: General Dynamics
Program office: Woodbridge, Va.
Funding needed to complete:
- R&D: $742.9 million
- Procurement: $8,437.9 million
- Total funding: $9,236.9 million
- Procurement quantity: 1,012

Program Performance (fiscal year 2006 dollars in millions)

	As of 12/2000	Latest 08/2005	Percent change
Research and development cost	$1,468.1	$2,358.5	60.6
Procurement cost	$6,581.1	$8,607.2	30.8
Total program cost	$8,133.8	$11,052.5	35.9
Program unit cost	$7.935	$10.783	35.9
Total quantities	1,025	1,025	0.0
Acquisition cycle time (months)	138	186	34.8

The EFV's technologies are mature and the design is stable. Early development of fully functional prototypes facilitated design stability. Technical problems have been encountered, and system reliability requirements have been reduced; plans are to fully demonstrate all requirements in fiscal year 2010. Fixes for technical problems have been identified and corrective actions are in place. Production maturity remains a concern because the contractor will not start collecting statistical process control data until after production starts, and the software development effort is a continuing challenge. A fourth program restructuring has resulted in a 2-year schedule increase and about a $2-billion increase in cost. The program office has had reduced insight into its prime contractor's work progress since December 2004 because it has not received detailed earned value cost and schedule data.

Attainment of Product Knowledge



EFV Program

Technology Maturity

All five of the EFV system's critical technologies are mature and have been demonstrated in a full-up system prototype.

Design Stability

The program has now released all of its drawings for the troop carrier and command variants, but anticipates that about 12 percent of the drawings will require changes to address reliability issues. While reliability requirements have been reduced, the program office expects to fully demonstrate both reliability and interoperability–key performance parameters--during initial operational testing and evaluation in fiscal year 2010. The program expects to hold a final design review in 2010 that will include any reliability design changes. Furthermore, testing in the early system design and demonstration phase revealed problems in the hull electronic unit, bow flap, and hydraulics. In addition, problems with the hardware and software modules caused unsafe testing conditions---the EFV prototypes made turns without a direct command. After about a two-month delay to address these problems, full vehicle testing was resumed. According to the program office, corrective actions for all these problems have been identified.

Production Maturity

The program plans to enter low-rate initial production in September 2006. However, the program office does not plan to require the contractor to collect statistical process control (SPC) data until after the start of low-rate-initial production to demonstrate that critical manufacturing processes will produce products within cost, schedule, performance, and quality targets. The program office is still in the planning stages for its production readiness reviews that will assess the production processes, identify any additional critical manufacturing processes, and determine the benefit of using SPC. According to the program office, to date, no suppliers have collected SPC data for EFV-unique components, but some suppliers are collecting SPC data on high-volume commercial parts used on the EFV. Twelve critical processes have already been identified and more are expected.

Other Program Issues

The EFV program relies on software to provide all electronic, firepower, and communication functions. The program is collecting metrics relating to cost, schedule, and quality; is using an evolutionary development approach; and has set and completed about 98 percent of the software requirements for the pending early operational assessment. Nevertheless, software development continues to present a risk. The program has already experienced growth in the size and cost of the software development as well as schedule delays. The program manager recognized the risk and has initiated a software risk mitigation plan.

DOD's December 2004 budgetary action to reallocate funding for higher priorities served as the basis for the EFV's fourth rebaselining. However, according to the program manager, a testing schedule slip of about 15 months would have been needed even without DOD's budgetary action because additional time would have been needed after the start of low-rate initial production in September 2006, for more robust reliability testing, production qualification testing and training. DOD's budgetary action resulted in a 24-month schedule increase---possibly 9 months more than would have been needed---and a cost increase of about $2 billion. According to the program office, the rebaselining effort was required in order to make the EFV program executable.

The program office has not collected and managed the program with detailed earned value management data since it began restructuring the program in December 2004. According to a program official, the earned value management system was re-established after a new contractor schedule was approved in December 2005.

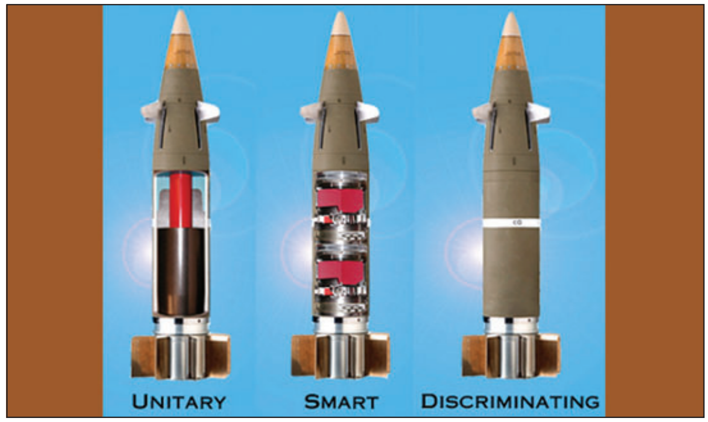
Agency Comments

The program office provided technical comments, which were incorporated, as appropriate. The Navy concurred with our assessment of the EFV program.

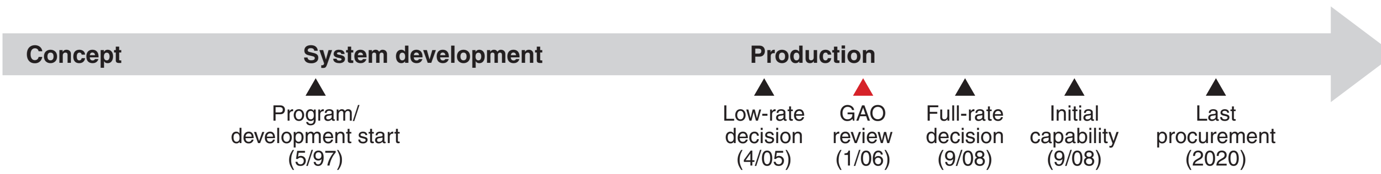
Further, the program manager believes the EFV program is on track to begin a comprehensive operational assessment in January 2006 and to begin its low-rate initial production review in September 2006.

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. It is intended to improve the accuracy and range of cannon artillery. Also, the Excalibur's near vertical angle of fall is intended to reduce the collateral damage area around the intended target, making it more effective in urban environments than the current artillery projectiles. The Future Combat Systems' non-line-of-sight cannon requires the Excalibur to meet its required range.



Source: PM Excalibur and Raytheon.



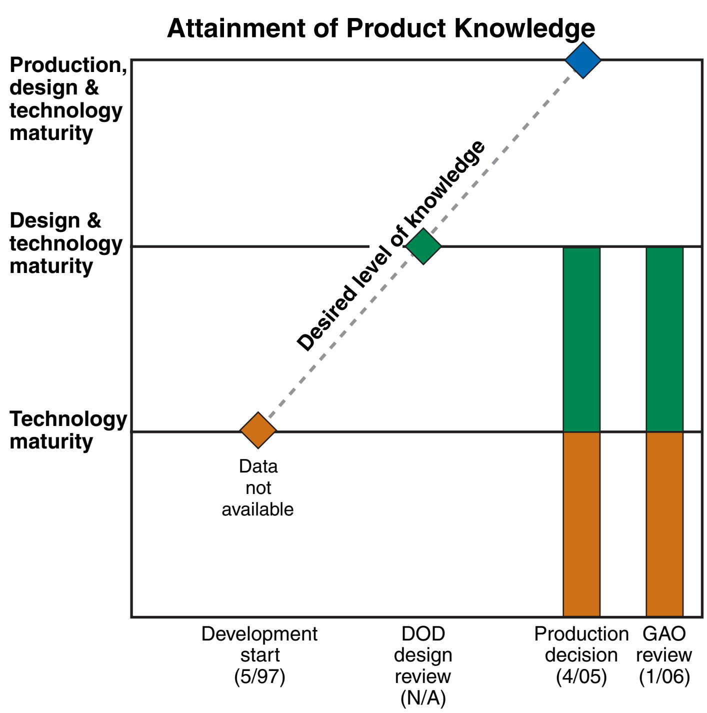
Program Essentials

Prime contractor: Raytheon, Tucson, Ariz.
Program office: Picatinny Arsenal, N.J.
Funding needed to complete:
- R&D: $376.0 million
- Procurement: $1,126.3 million
- Total funding: $1,502.2 million
- Procurement quantity: 29,900

Program Performance (fiscal year 2006 dollars in millions)

	As of 05/1997	Latest 09/2005	Percent change
Research and development cost	$62.4	$848.8	1,260.3
Procurement cost	$699.8	$1,143.2	63.4
Total program cost	$762.2	$1,992.0	161.3
Program unit cost	$.004	$.066	1,626.8
Total quantities	200,000	30,269	-84.9
Acquisition cycle time (months)	160	136	-15.0

The Excalibur program is proceeding into early production to support an urgent early fielding requirement in Iraq for more accurate artillery that will reduce collateral damage. This early production run of the Excalibur's first block will involve 180 rounds, with planned fielding by the last quarter of 2006. According to program officials, Excalibur's critical technologies reached full maturity in May 2005, and all of its 790 drawings were completed in July 2005. The Excalibur unitary variant will be developed in three blocks, which will incorporate increased capabilities and accuracy over time. Since our last assessment, the planned quantities have been cut in half. The program continues to experience increasing unit cost as quantities are lowered.



Excalibur Program

Technology Maturity

The Excalibur program is developing its unitary variant in three blocks. All three of the unitary variant's critical technologies reached full technology maturity in May 2005 at the time of the Excalibur's design review. These technologies were the airframe, guidance system, and warhead.

Design Stability

Excalibur's design appears to be stable because at the time of the May 2005 design review, 750 of 790 design drawings were releasable. All the drawings were complete for the first Excalibur block in July 2005. The second block is expected to have a similar number of drawings, and it is unknown how many drawings will be involved with the third block.

Production Maturity

We could not assess Excalibur's production maturity. The first block has entered limited production, to support an urgent fielding requirement in Iraq, without statistical control data. The program plans to collect statistical data during production of all blocks. Production of the second block is scheduled for fiscal year 2007 and the third block in fiscal year 2010.

Other Program Issues

The program has encountered a number of changes since development began in 1997, including a decrease in planned quantities, a relocation of the contractor's plant, early limited funding, technical problems, and changes in program requirements. It was almost immediately restructured due to limited funding, and it was restructured again in 2001. The program was again restructured in 2002 and merged with a joint Swedish/U.S. program known as the Trajectory Correctable Munition. This merger has helped the Excalibur deal with design challenges, including issues related to its original folding fin design. In May 2002, due to the cancellation of the Crusader, the Army directed the restructure of the program to include the Future Combat Systems' Non-Line-of-Sight Cannon.

In December 2002, the Acting Under Secretary of Defense (Acquisition, Technology, and Logistics) approved an early fielding plan for the unitary version. The plan currently includes developing the unitary version of the Excalibur in three blocks. In the first block, the projectile would meet its requirements for accuracy in a non-jammed environment and lethality and would be available for early fielding. In the second block, the projectile would be improved to meet its requirements for accuracy in a jammed environment and reliability and would be available for fielding to the Future Combat System's Non-Line-of-Sight Cannon in September 2008 or when the cannon is available. Finally, in the third block, the projectile would be improved to meet its range requirement and would be available for fielding to all systems in late fiscal year 2011.

The net effect of these changes has been to lengthen the program's schedule and to substantially decrease planned procurement quantities. As a result, the program's overall costs and unit costs have dramatically increased.

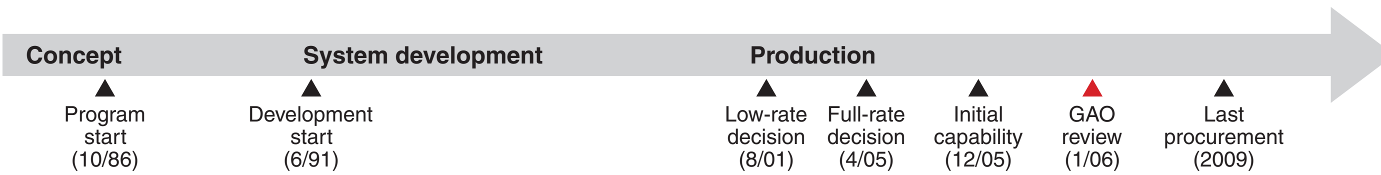
Agency Comments

In commenting on the draft, the Army noted that Excalibur started as a combination of three smaller artillery-related programs with the intent to extend range capability with an integrated rocket motor. The current Excalibur program will allow three different Army howitzers to fire farther away and defeat threats more quickly, lowering collateral damage while reducing the logistic support burden. Recent program achievements include a production decision for the first block configuration to support early fielding to the multinational combat forces in Iraq, and successful tests demonstrated both proximity and point-detonating modes approximately 5 meters from the target.

F-22A Raptor

The Air Force's F-22A, originally planned to be an air superiority fighter, will also have air-to-ground attack capability. It is being designed with advanced features, such as stealth characteristics, to make it less detectable to adversaries and capable of high speeds for long ranges. It also has integrated aviation electronics (avionics) designed to greatly improve pilots' awareness of the situation surrounding them. It is designed to replace the Air Force's F-15 aircraft.

Source: F-22A System Program Office.



Program Essentials

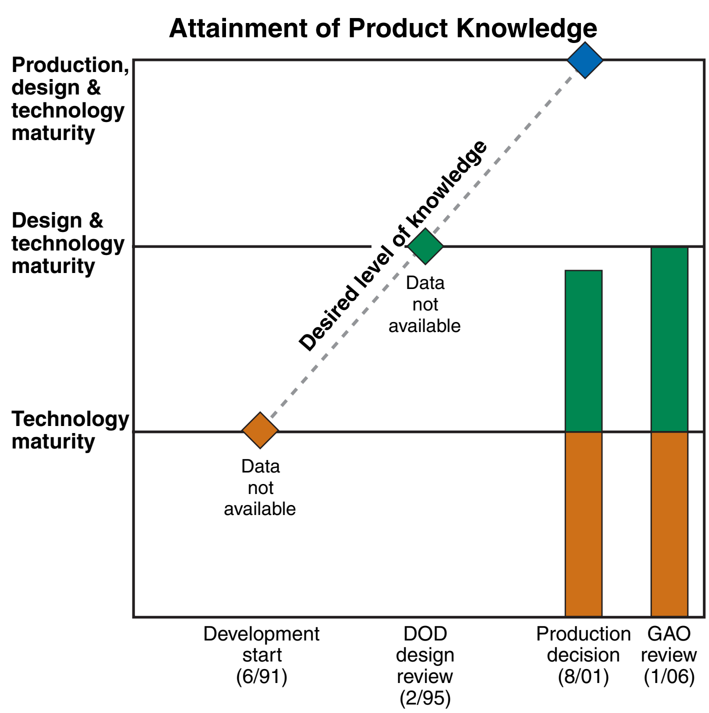
Prime contractor: Lockheed Martin
Program office: Dayton, Ohio
Funding needed to complete:
- R&D: $3,233.1 million
- Procurement: $16,965.4 million
- Total funding: $20,509.1 million
- Procurement quantity: 80

Program Performance (fiscal year 2006 dollars in millions)

	As of 02/1992	Latest 12/2004	Percent change
Research and development cost	$22,297.0	$32,808.7	47.1
Procurement cost	$58,536.3	$32,140.2	-45.1
Total program cost	$81,102.4	$65,396.9	-19.4
Program unit cost	$125.158	$361.309	188.7
Total quantities	648	181	-72.1
Acquisition cycle time (months)	203	231	13.8

In December 2005, the F-22A procurement quantities increased to 183 aircraft. The additional two aircraft are not reflected in this table.

The F-22A entered production without ensuring that production processes were in control. In December 2004, the Secretary of Defense reduced F-22A procurement quantites from 279 to 183. Since our last assessment of the program, the Air Force held a full rate decision in April 2005. At that time, about 42 percent of the aircraft were already on contract. Technology and design matured late in the program and have contributed to numerous problems. Avionics problems were discovered late in development, which resulted in large cost increases and caused testing delays. The Air Force completed initial operational test and evaluation in December 2004 and identified several deficiencies that required modfications to the aircraft's fuel system, canopy transparency, and the applications of low observable materials.



F-22A Program

Technology Maturity

The three critical F-22A technologies (supercruise, stealth, and integrated avionics) appear to be mature. However, two of these technologies, the integrated avionics and stealth, did not mature until several years after the start of development. Integrated avionics has been a source of major problems, delaying developmental testing and the start of initial operational testing. Since 1997 the costs of avionics has increased by over $951 million or 24 percent and problems discovered late in the program were the major contibutor. In April 2004, the Air Force began initial operational test and evaluation after reporting that these problems were corrected.

Design Stability

The F-22A design is essentially complete, but it matured slowly, taking over 3 years beyond the critical design review to meet best practice standards. The late drawing release contributed to parts shortages, work performed out of sequence, delayed flight testing, and increased costs. Design changes resulted from flight and structural tests. For example, problems with excessive movement of the vertical tails and overheating problems in the fuselage and engine bay required design modifications. The Air Force completed initial operational testing in December 2004 and development testing in December 2005. There were several design changes required to the aircraft as a result of operational testing. These included changes to improve the application of low observable materials, modifications to improve the durabilty of canopy transparencies, and implemented software improvements to the diagnostic health management system.

Production Maturity

The program office stopped collecting process control information in November 2000. The contractor estimated that nearly half of the key processess had reached a marginal level of control, but not up to best practice standards. The Air Force has 98 production aircraft on contract. The Air Force relies on the contractor's quality system to verify manufacturing and performance requirements are being met. However, the Air Force has not demonstrated the F-22A can achieve its reliability goal of 3 hours mean time between maintenance. It does not expect to achieve this goal until the end of 2009 when most of the aircraft will have already been bought. Best practices call for meeting reliability requirements before entering production. At the conclustion of initial operational test and evaluation in December 2004, the Air Force had only demonstrated about 15 percent of the reliability required to meet the current operational requirement.

Other Program Issues

The Air Force is counting on $2.2 billon in future cost reduction plans to offset estimated cost growth and enable the program to meet the latest production cost estimate. If these cost reduction initiatives are not achieved as planned, production costs could increase.

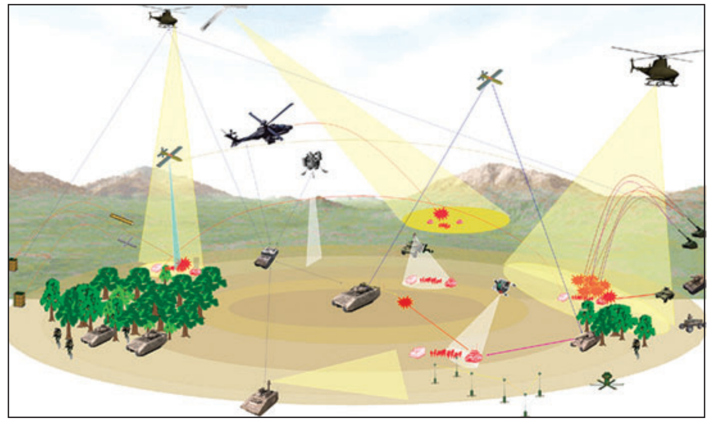
In January 2005, the Air Force Operatonal Test and Evaluation reported the F-22A was "overwhelmingly effective" as an air superiority fighter and that its support systems were "potentially suitable." Some deficiences were noted, particurly in reliability and maintainability. In August 2005, the Air Force begin follow-on test and evaluation, which is designed to demonstrate limited air-to-ground capability and correct the deficiencies identified during initial operational test and evaluation. The F-22A declared initial operational capability in December 2005.

Agency Comments

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

Future Combat Systems (FCS)

The FCS, a program that will equip the Army's new transformational modular combat brigades, consists of a family of systems composed of advanced, networked combat and sustainment systems, unmanned ground and air vehicles, and unattended sensors and munitions. Within a system-of-systems architecture, the first increment of the FCS features 18 major systems and other enabling systems along with an overarching network for information superiority and survivability.



Source: Program Manager, Unit of Action, U.S. Army.

Concept | System development | Production

- Program start (5/00)
- Development start (5/03)
- GAO review (1/06)
- Design review (9/10)
- Low-rate decision (9/12)
- Initial capability (12/14)
- Full-rate decision (8/16)
- Last procurement (unknown)

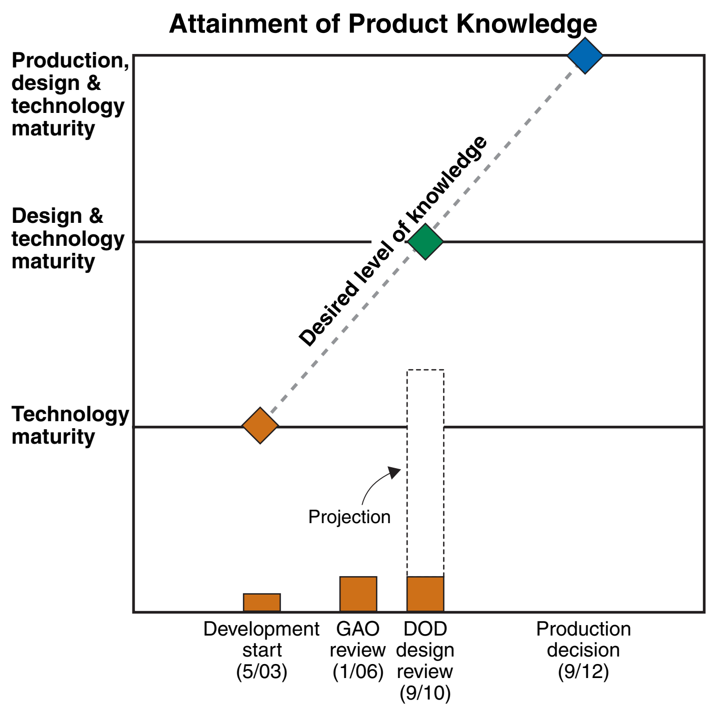
Program Essentials

Prime contractor: Boeing
Program office: Hazelwood, Mo.
Funding needed to complete:
R&D: $23,579.1 million
Procurement: $98,469.7 million
Total funding: $122,724.2 million
Procurement quantity: 15

Program Performance (fiscal year 2006 dollars in millions)

	As of 05/2003	Latest 09/2005	Percent change
Research and development cost	$19,206.3	$28,359.4	47.7
Procurement cost	$62,718.9	$98,469.7	57.0
Total program cost	$82,561.9	$127,504.6	54.4
Program unit cost	$5,504.127	$8,500.305	54.4
Total quantities	15	15	0.0
Acquisition cycle time (months)	91	139	52.8

The FCS program has not demonstrated high levels of knowledge. Requirements have been sent to system developers to begin preliminary designs, but program officials say they may change due to feasibility and affordability constraints. Three years after system development began, none of FCS' 49 critical technologies are fully mature. Technology maturation will continue throughout system development, with an associated risk of cost growth and schedule delays. Based on program office estimates, the cost of the restructured FCS program has grown substantially. Earlier cost estimates were based on lower levels of program knowledge and undefined requirements. Higher levels of knowledge have resulted in a more realistic and higher cost estimate. Since the FCS dominates Army investment accounts over the next decade, further cost growth and schedule delays could affect other Army acquisitions.



FCS Program

Technology Maturity
Since our last assessment of FCS, the program assembled an independent review team to assess critical technologies. Although a few technologies appear to have matured, most have either shown no improvement or are now assessed less mature. None of the FCS program's critical technologies are fully mature and only 18 technologies are nearing full maturity.

The program is no longer reporting on 5 of the 54 technologies from a year ago. According to FCS officials, they met last year with the users' representative, the Army Training and Doctrine Command, to discuss FCS requirements and critical technologies. They agreed that a few of the listed technologies were in fact not technologies. Instead, they were capabilities that could be satisfied by existing or planned assets.

The FCS program is not following best practices in maturing its technologies. The program's approach involves integration phases that allow a staggered start for technologies to be "spun out" to current forces. However, program officials allow technologies to be included in the integration phases before they are mature. Further, as currently scheduled, all four of the currently-planned integration phases will have begun before the program has a preliminary design review for the system of systems, and each of those integration phases will likely begin with immature technologies. As a result, the program will involve concurrent technology and product development and face the associated risks of such an approach. Furthermore, the individual integration phases will not be subjected to the milestone decision process.

Other Program Issues
The cost of the restructured FCS program has increased substantially, based on program office estimates. An independent cost estimate will not be completed until the spring of 2006. Projected procurement costs have increased over 50 percent. Earlier cost estimates were based on lower levels of program knowledge and undefined requirements. Higher levels of knowledge, such as more defined design concepts for the manned ground vehicles and progress in requirements definition, have produced a higher fidelity cost estimate. The Army has adopted an initiative to substantially reduce FCS procurement acquisition costs. However, requirements may have to be reduced accordingly.

In August 2005, the FCS program completed the System of Systems Functional Review. This event demonstrated that the Army understands FCS system of systems requirements and is prepared to begin preliminary individual system designs. Although it is a significant achievement, the program should have demonstrated this level of knowledge 3 years ago to support the decision to start development. In addition, program officials say they are reserving the right to reduce requirements, pending user approval, if technologies do not mature as planned or if satisfying a particular requirement is not affordable. The requirements uncertainty and immature state of technologies make the FCS acquisition approach risky. Furthermore, successful operation of FCS-equipped Units of Action depends on the contributions of up to 170 complementary and associated programs. FCS will utilize these systems to help satisfy FCS operational requirements. However, according to program officials, the list of complementary programs continues to evolve and some are unfunded.

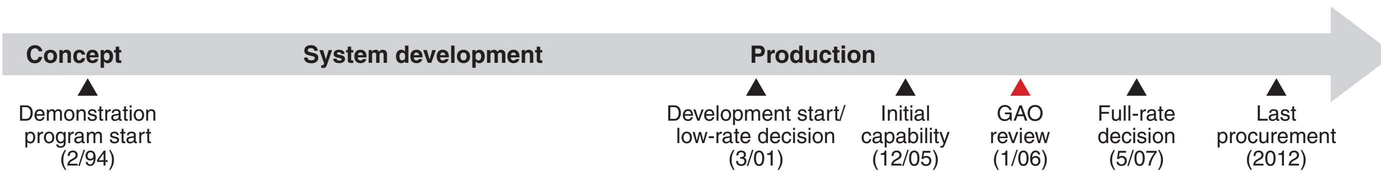
Agency Comments
In commenting on a draft of this assessment, the Army stated that technology maturity is a key aspect of the process of deciding when a technology is provided to current forces. It also stated that while the individual integration phases will not be subjected to the milestone decision process, the program will have annual reviews with the milestone decision authority. The Army commented that the program is primarily focused on about 52 critical complementary programs considered essential to meeting the top-level key performance parameters.

GAO Response
Although technology maturity may drive decisions on providing technologies to the current forces, the Army's definition of mature technology is below the best practices standard. Our prior work has shown that when programs proceed into development with technologies that do not comply with best practices, they are exposed to an increased risk of cost growth and schedule delays. Also, the list of critical complementary programs continues to evolve, and the program must manage the associated cost, schedule, and performance gaps that may result.

Global Hawk Unmanned Aircraft System

The Air Force's Global Hawk system is a high altitude, long endurance unmanned aerial vehicle with integrated sensors and ground stations providing intelligence, surveillance, and reconnaissance capabilities. After a successful technology demonstration, the system entered development and limited production in March 2001. Considered a transformational system, the program was restructured twice in 2002 to acquire 7 air vehicles similar to the original demonstrators (the RQ-4A) and 44 of a new, larger, and more capable model (the RQ-4B).

Source: Northrop Grumman Corporation.



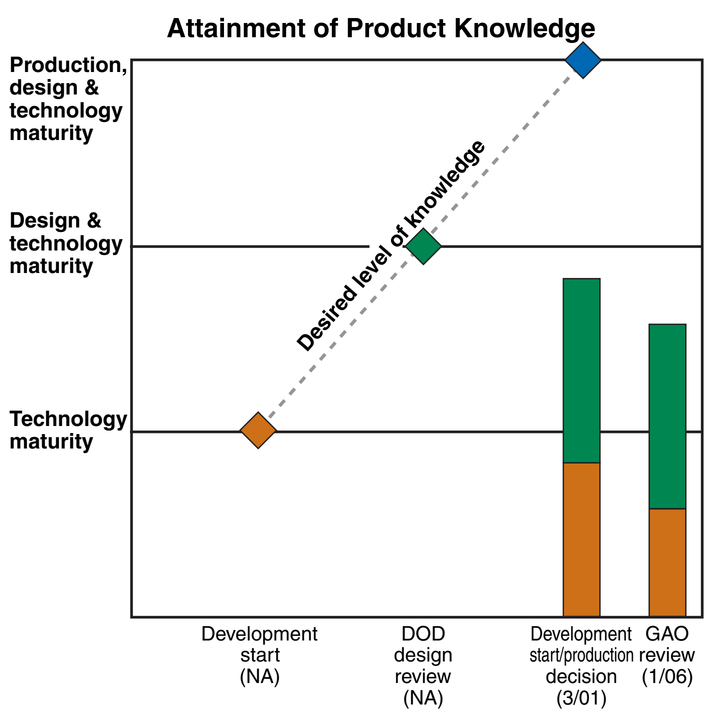
Program Essentials

Prime contractor: Northrop Grumman Integrated Systems
Program office: Dayton, Ohio
Funding needed to complete:
R&D: $1,053.3 million
Procurement: $2,773.0 million
Total funding: $3,913.8 million
Procurement quantity: 37

Program Performance (fiscal year 2006 dollars in millions)

	As of 03/2001	Latest 09/2005	Percent change
Research and development cost	$925.2	$2,459.1	165.8
Procurement cost	$3,836.2	$3,761.0	-2.0
Total program cost	$4,789.5	$6,352.4	32.6
Program unit cost	$76.024	$124.557	63.8
Total quantities	63	51	-19.0
Acquisition cycle time (months)	55	57	3.6

Key product knowledge on Global Hawk is lower now than in March 2001 due to program restructurings. Under the original plan to produce aircraft very similar to demonstrators and slowly acquire advanced systems, technology maturity and design stability were near best practices standards. Program restructurings, however, added the new RQ-4B aircraft and advanced sensors, overlapped development and production schedules, and accelerated planned deliveries. The new technologies are still maturing and the RQ-4B design required extensive changes. Officials are implementing statistical process controls, but data is incomplete. In November 2004, we reported significant risks from gaps in product knowledge and recommended reducing near-term RQ-4B buys to only those needed for testing. The program is now experiencing development and procurement cost increases, schedule delays, and quality problems.



Global Hawk Program

Technology Maturity

Of the Global Hawk's 13 critical technologies, 6 are mature by best practices standards; 3 are approaching maturity; and 4 are less mature. The less mature technologies include enhanced imagery and signals intelligence sensors and improved radar. The desire for these capabilities drove the decision to develop and acquire the new RQ-4B aircraft, which can carry 50 percent more payload than the RQ-4A. Integrating and testing advanced sensors won't be completed until late in the program after most of the fleet has already been bought. If space, weight, and power limitations or other performance issues surface as technologies mature, the program may experience costly rework, extended development times, or diminished capabilities.

Design Stability

Program officials reported achieving the best practice standard for design drawings approved for manufacturer release in October 2004, shortly after RQ-4B production began. However, during the first year of production, there were more than 2,000 authorized drawing changes to the total baseline of 1,400 drawings. More than half of those changes were considered major, requiring model changes. Substantial commonality between the A- and B-models had been expected, but as designs were finalized and production geared up, design differences were more extensive and complex than anticipated. By the time of our review, design deficiencies, engineering changes, and work delays had contributed to a development contract cost overrun of $209 million. Adding to design risk, the Air Force plans to buy almost half the RQ-4B fleet before it completes operational tests to verify the aircraft design.

Production Maturity

The contractor has completed RQ-4A production and is fabricating the first RQ-4Bs. Program and contractor officials are in the process of implementing statistical process controls.They've identified critical manufacturing processes and started to collect data for demonstrating that new processes are capable of meeting cost, schedule, and quality targets. Officials also collect and analyze other performance indicators such as defects and rework rates to monitor manufacturing quality. Technology immaturity, increased cost for sensors, and extensive design changes contributed to higher RQ-4B production costs than forecast. Although improving, there have been recurring concerns about the performance and work quality of several key subcontractors. The subcontractor building the tail scrapped seven of the first eight main box spars due to design maturity and process issues. The wing manufacturer terminated its subcontractor due to poor performance and quality; subsequently completed wings passed proof load testing and were installed onto RQ-4B aircraft.

Other Program Issues

With RQ-4B costs increasing and schedules slipping, the Global Hawk program is rebaselining, its fourth since the March 2001 start. In April 2005, the Air Force notified the Congress of a Nunn-McCurdy breach (see U.S.C. 2433) with an 18-percent unit procurement cost increase over the current baseline. Further cost increases are expected. In December 2005, we reported that the Nunn-McCurdy notice to Congress did not include $400.6 million (in base year 2000 dollars) budgeted for retrofit activities, including the procurement and installation of signal intelligence sensors in already-built aircraft. Including this amount would increase procurement unit cost growth to 31 percent and require the Secretary of Defense to certify the program to Congress.

Agency Comments

In commenting on a draft of this product, Air Force officials partially concurred and offered technical comments that we incorporated where appropriate. They emphasized Global Hawk's early and continuing support to military operations in Iraq and Afghanistan with about 5,000 combat hours flown by demonstrator aircraft. They stated that DOD conducts comprehensive and forward-looking oversight, understands the risks and benefits, and implements an appropriate acquisition strategy to mitigate risk. Software, not hardware, is the critical element to the RQ-4B capability, drives the deployment schedule, and represents the chief technical and management challenges. Radar and signals sensors are the two critical technologies and portend revolutionary capability improvement. Each payload has a dedicated program office and contractor. Payload integration includes test and decision points to evaluate progress.

Ground-Based Midcourse Defense (GMD)

MDA's GMD element is being developed to defend the United States against limited long-range ballistic missile attacks. The first block, Block 2004, consists of a collection of radars and interceptors, which are integrated by a central control system that formulates battle plans and directs the operation of GMD components. We assessed the maturity of all technologies critical to the Block 2004 GMD element, but we assessed design and production maturity for the interceptors only.

Source: Department of Defense.

Program Essentials

Prime contractor: Boeing Company
Program office: Arlington, Va.
Funding, FY06-FY11:
R&D: $12,410.2 million
Procurement: $0.0 million
Total funding: $12,410.2 million
Procurement quantity: NA

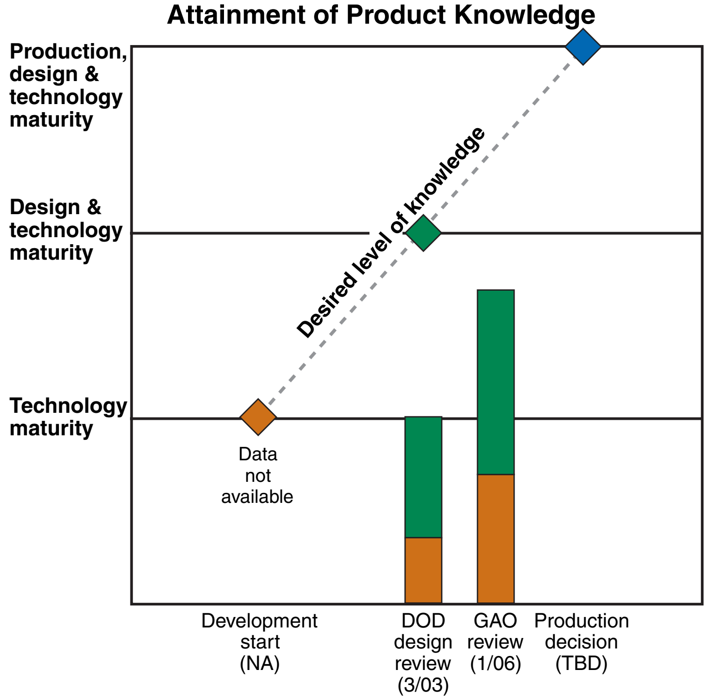
Program Performance (fiscal year 2006 dollars in millions)

	As of 02/2003	Latest 07/2005	Percent change
Research and development cost	$23,265.3	$29,167.0	25.4
Procurement cost	$0.0	$0.0	0.0
Total program cost	$23,265.3	$29,167.0	25.4
Program unit cost	NA	NA	NA
Total quantities	NA	NA	NA
Acquisition cycle time (months)	TBD	TBD	TBD

Costs are for all known blocks from the program's inception through fiscal year 2009. Total known program funding through fiscal year 2011 is $32,439.8 million.

Even though only 6 of GMD's 10 critical technologies are fully mature, MDA released all hardware drawings to manufacturing and had 10 Block 2004 interceptors in silos for operational use by December 2005. However, ongoing efforts to mature technologies, along with concurrent testing and fielding efforts may lead to additional design changes. Although MDA is producing hardware for operational use, it has not made a formal production decision. Additionally, we could not assess the stability of the production processes because the program is not collecting statistical data for them. We expect that the prime contract could overrun its target cost by as much as $1.5 billion.

Attainment of Product Knowledge



GMD Program

Technology Maturity

Program officials assessed all of GMD's 10 critical technologies as mature. However, four have not been demonstrated in an operational environment and we believe that they cannot be considered fully mature. Mature technologies include the fire control software, the exoatmospheric kill vehicle (EKV) infrared seeker, the Orbital Sciences Corporation booster, the Cobra Dane radar, the EKV guidance, navigation, and control subsystem; and the in-flight interceptor communications system. The remaining four technologies are nearing maturity. These technologies are the Beale radar; EKV discrimination; the sea-based X-band radar; and the BV+ booster. The program expected to demonstrate all remaining technologies in an operational environment by December 2005, but flight test delays and failures prevented the demonstrations. The program now plans to demonstrate the remaining four technologies by the end of 2007.

Design Stability

Technology issues aside, the design of the Block 2004 ground-based interceptor appears stable with 100 percent of its drawings released to manufacturing. However, ongoing efforts to mature technologies and the concurrent testing and fielding efforts may lead to additional drawings and design changes.

Production Maturity

Officials do not plan to make an official production decision, although they are delivering interceptors for the Block 2004 emergency capability. We could not assess the maturity of the production processes for these interceptors because the program is not collecting statistical control data. According to program officials, data are not tracked because current and projected quantities of GMD component hardware are low. Instead, the GMD program measures production capability and maturity with a monthly evaluation process called a Manufacturing Capability Assessment that assesses critical manufacturing indicators for readiness and execution.

MDA delivered 5 interceptors for the initial capability by September 2004, and it had 10 interceptors ready for alert by December 2005. MDA planned to have 18 interceptors fielded by this time; however, 4 interceptors procured for fielding were later designated as test assets and production of 4 others was delayed as quality control improvements were implemented.

Qualification of a new BV+ booster propellant subcontractor has been completed ending a 2 year slowdown in BV+ activities. MDA plans to procure the eight BV+ boosters currently under contract, but these interceptors will not be fielded until Block 2006.

Other Program Issues

GMD's prime contractor, Boeing, has overrun its budget by $600 million, primarily because of quality issues that delayed flight and ground tests. Although Boeing expects the large unfavorable cost variances to improve as flight testing resumes, we anticipate that the contract will overrun its target cost by as much as $1.5 billion. Since our last assessment, GMD's planned budget through fiscal year 2009 has increased by $2.9 billion (11.2 percent), primarily in fiscal years 2008 and 2009.

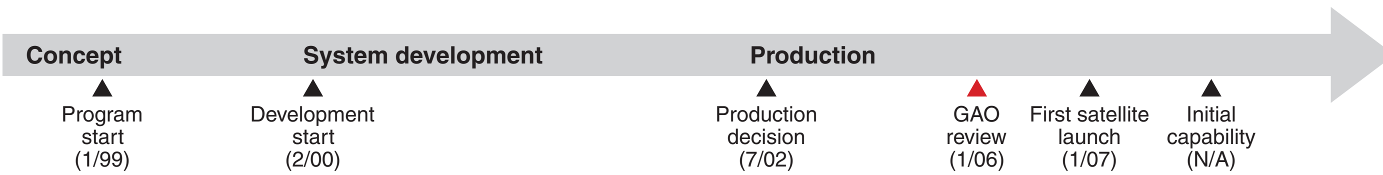
Agency Comments

The program office provided technical comments to a draft of this assessment, which were incorporated as appropriate.

Navstar Global Positioning System (GPS) II Modernized Space/OCS

GPS is an Air Force-led joint program with the Army, Navy, Department of Transportation, National Geo-Spatial Intelligence Agency, United Kingdom, and Australia. This space-based radio-positioning system nominally consists of a 24-satellite constellation providing navigation and timing data to military and civilian users worldwide. In 2000, Congress approved the modernization of Block IIR and Block IIF satellites. In addition to satellites, GPS includes a control system and receiver units. We focused our review on the Block IIF.

Source: Navstar GPS Joint Program Office, Space and Missile Systems Center.



Program Essentials

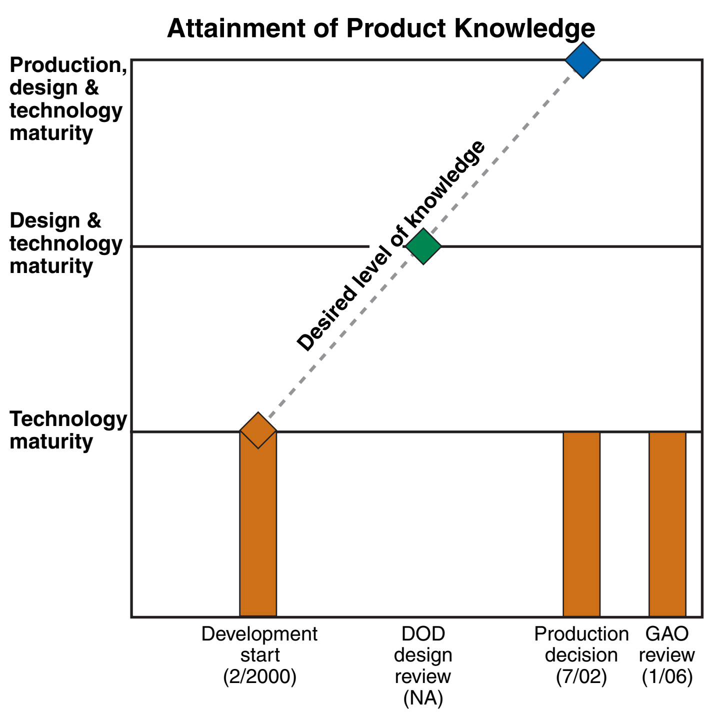
Prime contractor: Boeing for IIF, Boeing for OCS, Lockheed Martin for IIR-M
Program office: El Segundo, Calif.
Funding needed to complete:
- R&D: $575.5 million
- Procurement: $1,256.3 million
- Total funding: $1,831.8 million
- Procurement quantity: 10

Program Performance (fiscal year 2006 dollars in millions)

	As of 02/2002	Latest 12/2004	Percent change
Research and development cost	$1,955.5	$2,354.3	20.4
Procurement cost	$3,566.4	$4,283.4	20.1
Total program cost	$5,522.0	$6,637.7	20.2
Program unit cost	$167.332	$165.942	-0.8
Total quantities	33	40	21.2
Acquisition cycle time (months)	TBD	TBD	TBD

Costs and quantities include Block IIR, IIR-M, and IIF satellites, and the Operational Control System (OCS). Lockheed Martin is the contractor for IIR and IIR-M. Boeing is the contractor for IIF and OCS.

According to the program office, the Block IIF technologies are mature. Since the start of the GPS program in 1973, GPS satellites have been modernized in blocks with the newer blocks providing additional capabilities and benefits. The space-qualified atomic frequency standards for the Block IIF satellites are mature but considered a critical technology because there is no backup technology for these clocks. The contractor was not required to provide data on design drawings, and statistical process control techniques are not being used to monitor production. As a result, design stability and production maturity could not be assessed. R&D cost growth amounted to $399 million (20.4 percent) for satellite component modernization and the control system, and procurement cost growth amounted to $717 million (20.1 percent) to procure seven additional IIF satellites.



GPS Block II Modernization Program

Technology Maturity

The only critical technology on the Block IIF satellites is the space-qualified atomic frequency standards and is considered mature. However, maintaining an industrial base capable of manufacturing frequency standards for GPS appears to be an issue.

Design Stability

We could not assess design stability because the Block IIF contract does not require that design drawings be delivered to the program. However, the program office assesses design maturity by reviewing contractor development testing, participating in technical interchange meetings and periodic program reviews, and conducting contractor development process and configuration audits. The contractor for the Block IIF satellites faced significant challenges designing and implementing the programming logic for the Application Specific Integrated Circuit microcircuit chips. Failure to recognize and understand the complexity of the Application Specific Integrated Circuit design and delays in security clearances resulted in $46 million in cost overruns. To offset the overruns, the program office reallocated $22 million, and the Congress approved $24 million to be reprogrammed from other space programs. According to program officials, additional Block IIF satellites are not expected to experience cost increases because the microcircuit chip problem has been resolved with a dual design.

Production Maturity

We could not assess production maturity because the contractor does not collect statistical process control data. However, the program office reviews earned value management reports, integrated master schedules, and test dates as a means of monitoring the contractors' production efforts. When monthly earned value management reports and schedule reviews show cost overruns and/or schedule slips, the program office may choose to request additional information from the contractor.

Other Program Issues

The GPS Operational Control System consists of monitor stations that track the navigation signals of all the satellites, remote ground antennas that actively send commands to the satellite constellation, and two master control stations (primary and backup) that update the satellites' navigation messages. Software for the control system, referred to as Version 6, is needed to support the operational capability of the satellites with new military code signals. The first satellite with the new military code was launched in September 2005 and a total of 18 satellites with this code need to be on orbit to provide initial operational capability to military users. The program office estimates that 18 satellites will be on orbit in fiscal year 2011, but that Version 6 will not be operational until fiscal year 2012. Thus the satellites on orbit with the new military code, while supporting constellation sustainment, will not be fully utilized.

Under the current schedule the initial operational capability for Version 6 had already slipped from 2008 to 2010, because funding was reallocated to complete development of Block IIF satellites to sustain the GPS constellation. During 2005, the program office reorganized and stopped work on Version 6 due to the reduced funding and concerns about parallel development of two different control systems, Block II and Block III (the next generation of satellites and a new control system), by potentially two different contractors. The program office plans to award a single competitive contract for Version 6 and the Block III control system with a first increment that will enable full military code capability in 2012.

R&D cost growth amounted to $399 million (20.4 percent) for satellite component modernization and the control system, and procurement cost growth amounted to $717 million (20.1 percent) to procure seven additional IIF satellites.

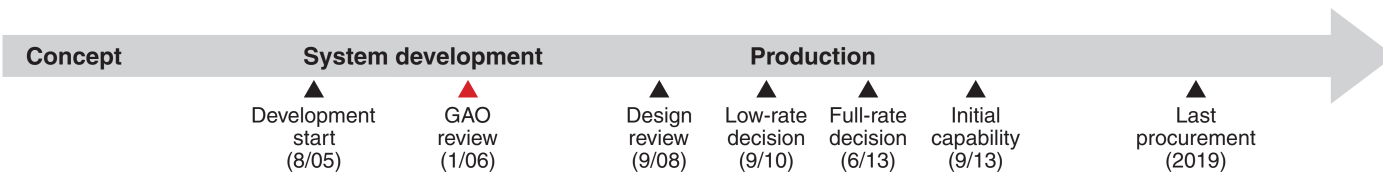
Agency Comments

The Air Force generally concurred with this assessment and provided technical comments, which were incorporated as appropriate.

Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System

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 completed and served as a test bed to demonstrate initial capability. 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 provides surveillance and engagement support to other systems, such as PAC-3 and MEADS. We assessed Spiral 2.

Source: Cruise Missile Defense Systems Project Office, JLENS Product Office.



Program Essentials

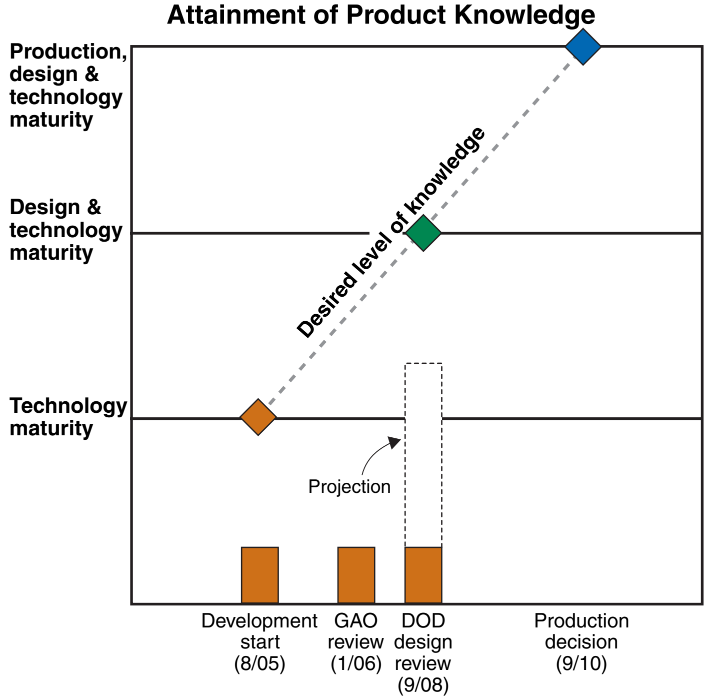
Prime contractor: Raytheon
Program office: Huntsville, Ala.
Funding needed to complete:
R&D: $1,795.2 million
Procurement: $4,107.5 million
Total funding: $5,967.0 million
Procurement quantity: 14

Program Performance (fiscal year 2006 dollars in millions)

	As of NA	Latest 09/2005	Percent change
Research and development cost	NA	$1,795.2	NA
Procurement cost	NA	$4,107.5	NA
Total program cost	NA	$5,967.0	NA
Program unit cost	NA	$372.935	NA
Total quantities	NA	16	NA
Acquisition cycle time (months)	NA	97	NA

The program began development in August 2005 with one of its five critical technologies mature. The Army determined that JLENS is primarily an integration effort based on relatively mature technologies from other programs and concluded that none of JLENS technologies meet the definition of a critical technology. However, we identified five technologies in its technology assessment that could be defined as critical because they are essential to JLENS capabilities and integrating them will involve changes in size, the arrangement and interconnections of subcomponents, and software development challenges. The program plans to release 90 percent of the engineering drawings by the design review; however, the program faces risk of redesign until technologies demonstrate full maturity.

Attainment of Product Knowledge



JLENS Program

Technology Maturity

JLENS entered system development in August 2005 with one of its five critical technologies mature. The communications payload technology consisting of radios and fiber optic equipment is fully mature and the processing station technology--which serves as the JLENS operations center--is approaching full maturity. Both sensors--the precision track illumination radar (PTIR) and the surveillance radar (SUR) along with its platform--are not yet mature.

In June 2005, the Office of the Deputy Assistant Secretary of the Army for Research and Technology determined that JLENS is primarily an integration effort based on relatively mature technologies from other programs and therefore concluded that none of the JLENS technologies meet the definition of a critical technology. According to the project office, many of the JLENS technologies have legacy components that have either been tested or fielded in an environment similar to the expected JLENS deployment environment. However, we identified five critical technologies based on review of the program's technology maturity assessment, an independent assessment by the Army's Aviation and Missile Research Development and Engineering Center (AMRDEC), and through discussions with program officials. We determined that these technologies are critical because they are essential to the attainment of JLENS' required capabilities, and some will require physical modification and demonstration of subcomponents for use in the JLENS operational environment.

The JLENS sensors support its primary mission to acquire, track, classify, and discriminate targets and are being developed using components from other programs such as MDA's THAAD and the Navy's SPY-3 Radar used on the DD(X) and the Marine Corp's Affordable Ground Based Radar. Although the PTIR is similar to the design of the existing SPY-3 radar and the program has developed prototypes of PTIR components, the radar is not yet mature because only a partial structure of the antenna has been built in prototype form. The antenna structure is a key component for maintaining the weight requirements of the PTIR and has yet to be demonstrated for the JLENS application. Furthermore, the antenna patch assemblies, used to transmit and receive radio frequency energy, will require unique circuitry and design changes to meet form and fit requirements. According to program officials, tests to integrate the PTIR prototype components will occur sometime in fiscal year 2006.

While approximately 80 percent of the software used by the PTIR is from the SPY-3 radar, nearly two-thirds of the software used by the SUR sensor will need to be developed or modified. Also, the SUR uses a different processor than legacy software, and some new modules have yet to be tested. According to program officials, software items for the SUR are the primary challenges for achieving technology maturity because they are still being developed and designed. The program expects to fully demonstrate full maturity of these items in 2009.

The JLENS platform consists of the aerostat, mobile mooring station, power and fiber optic data transfer tethers, and ground support equipment. The mobile mooring station, used to anchor the aerostat during operations, is based on a fixed mooring station design. However, it is the least well-defined component of the JLENS system because a mobile mooring station for large aerostats has never been developed. As a result, the current mooring station will need modifications in order to meet JLENS mobility requirements.

Design Stability

Program officials estimate that 90 percent of its 6,230 drawings will be released by the design review scheduled for September 2008. However, until the maturity of the JLENS' critical technologies has been demonstrated, the potential for design changes remains.

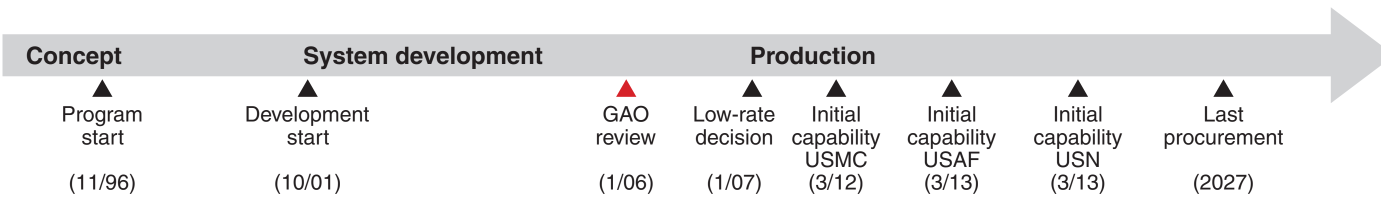
Agency Comments

In commenting on a draft of this assessment, the Army stated that the JLENS technology maturity and technology readiness assessments were reviewed by the Department of the Army and the Office of the Secretary of Defense prior to the JLENS Defense Acquisition Board review that was held in June 2005. Based upon these and the independent assessment conducted by AMRDEC, the review board concluded that the JLENS technologies were at an appropriate maturity level to proceed into the development phase of the program. The Army also stated that as the program moves further into development, it is anticipated that these technologies will prove out in the integration process.

Joint Strike Fighter (JSF)

The JSF program goals are to develop and field a family of stealthy, strike fighter aircraft for the Navy, Air Force, Marine Corps, and U.S. allies, with maximum commonality to minimize costs. The carrier suitable version will complement the Navy's F/A-18 E/F. The conventional take-off and landing version will primarily be an air-to-ground replacement for the Air Force's F-16 and the A-10 aircraft, and will complement the F-22A. The short take-off and vertical landing version will replace the Marine Corps' F/A-18 and AV-8B aircraft.

Source: JSF Program Office.



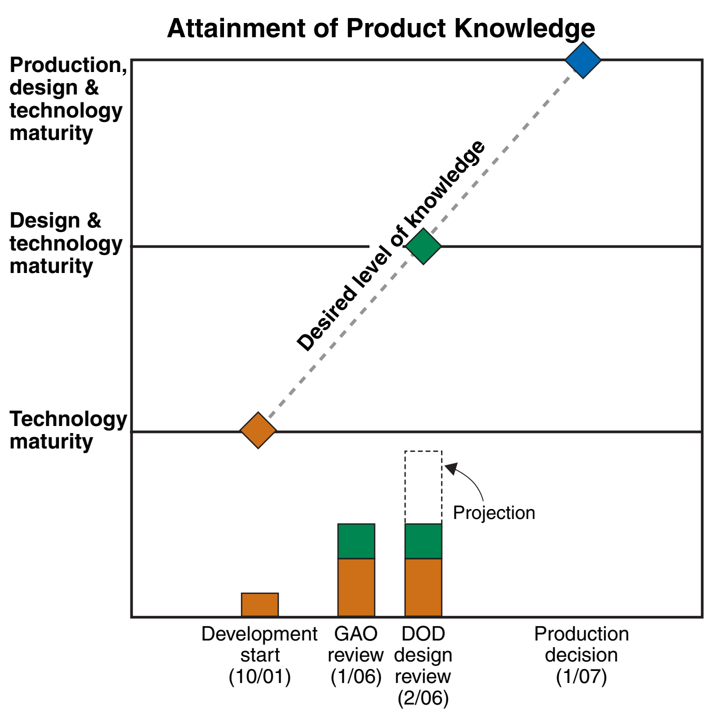
Program Essentials

Prime contractor: Lockheed Martin
Program office: Arlington, Va.
Funding needed to complete:
R&D: $24,717.5 million
Procurement: $161,111.5 million
Total funding: $185,980.0 million
Procurement quantity: 2,443

Program Performance (fiscal year 2006 dollars in millions)

	As of 10/2001	Latest 12/2004	Percent change
Research and development cost	$34,615.8	$45,021.2	30.1
Procurement cost	$153,590.6	$161,111.5	4.9
Total program cost	$189,814.1	$206,339.2	8.7
Program unit cost	$66.230	$83.946	26.7
Total quantities	2,866	2,458	-14.2
Acquisition cycle time (months)	185	196	6.0

JSF program data indicates that 7 of the system's 8 critical technologies will not be fully mature until after the first design reviews in 2006. Not only is design stability not projected by the time of those reviews, one of the two variants to be reviewed in 2006 is expected to have released significantly fewer drawings than suggested by best practices. Furthermore, the demonstration of a production representative aircraft that includes design changes to reduce weight will not occur until late 2007, after the start of production. Less than a year after the design review, the program plans to enter production with little demonstrated knowledge about performance and producibility. Software also poses a risk as the program plans to develop nearly 19 million lines of code. At the production decision, the program will have released about 35 percent of the software needed for the system.



JSF Program

Technology Maturity

The JSF entered development without its eight critical technologies being mature. Recent data provided by the program office indicates that maturity has progressed; however, seven technologies are still not fully mature and are not expected to be until after the design review.

Design Stability

Currently, 26 percent of the short take-off and vertical landing variant and less than 3 percent of the conventional variant drawings have been released. Design reviews for these variants are scheduled for February 2006. Program data indicates that 75 percent of the drawings for the short take-off and vertical landing variant and 18 percent of the conventional variant are expected to be released by that time. Program officials state that these represent the most critical drawings. The program has not yet prototyped any of the expected designs. An early prototype is expected to have its first flight in August 2006, but does not include many of the design changes that resulted from an effort to reduce airframe weight. The first demonstration of a prototype that incorporates the design changes is scheduled for late 2007. The carrier version design review is not scheduled until late 2006. It will not be until 2009 that all three variants will be undergoing flight testing.

Production Maturity

The program plans to enter low rate production in early 2007 without demonstrating production maturity. The program is taking steps to collect key information on the maturity of manufacturing processes but will not demonstrate that the aircraft can be produced efficiently by the production decision. If schedules are met, the program will deliver only one nonproduction representative aircraft before the production decision. This aircraft, while not yet complete, has experienced labor inefficiences, part shortages, and major work performed out of sequence. The program will also not demonstrate that the aircraft works as intended. At the production decision, it will (1) have completed less than 1 percent of the planned flight test program, (2) not have flight tested a fully configured and integrated JSF, (3) have released only 35 percent of the software needed for the system, and (4) have little or no data from full scale structural testing. Before development is complete in 2013, DOD plans to buy 424 low rate production aircraft at an estimated cost of about $49 billion. DOD plans to use cost reimbursement-type contracts for its initial production orders, meaning that the government will pay any cost overruns.

Other Program Issues

The program plans to develop about 19 million lines of software code. Officials consider software a high risk item. The first of five major software blocks is scheduled to be released in June 2006 to support first flight. However, the Defense Contract Management Agency projects that this release could be delayed 1 to 3 months. Subsequent blocks are showing early indications of falling behind as well.

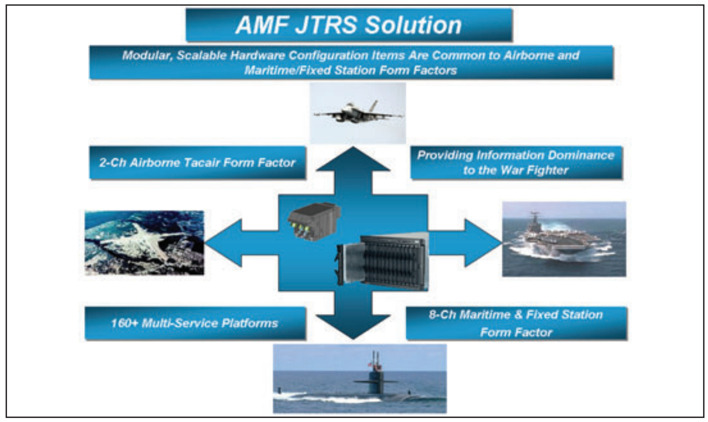
At this point the cost estimate represents the program office's position. The OSD Cost Analysis Improvement Group was to update its formal independent cost estimate in the spring of 2005, but now does not expect to formally complete its estimate until after the 2006 design review. However, a preliminary estimate was higher than the program office's with large projected funding shortfalls in the 2007 to 2011 time frame.

Agency Comments

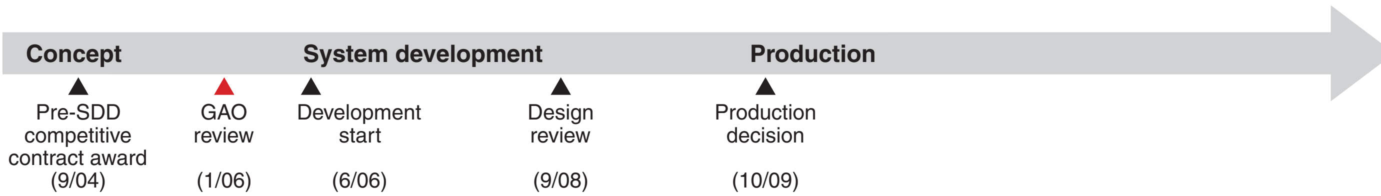
The JSF Program Executive Officer continues to nonconcur with GAO's methodology and conclusions on technology maturity. Hardware and software integration for multiple subsystems is ongoing in labs, years sooner than in legacy programs. Critical design reviews were completed in March 2004 for all design areas except the airframe. The air system design review in early 2006 will evaluate design maturity and performance against requirements. Manufacturing of the first test aircraft is well underway with much shorter assembly times than planned and exceptional quality demonstrated in fabrication, assembly, and mate. As of November 2005 the actual weight of 7,600 delivered components is within 1 percent of predictions. While the first aircraft lacks some design improvements, demonstrated processes and outcomes justify high confidence in design and weight predictions for all variants due to commonality of design, tools, and manufacturing methods. JSF acquisition strategy, including software development, reflects a block approach. Development is on track.

Joint Tactical Radio System Airborne, Maritime, Fixed-Site (JTRS AMF)

The JTRS program is developing software-defined radios that will interoperate with existing radios and also increase communications and networking capabilities. A Joint Program Executive Office provides a central acquisition authority and balances acquisition actions across the services. Program/product offices are developing radio hardware and software for users with similar requirements. The Air Force/Navy-led AMF program is developing radios that will be integrated into over 160 different types of aircraft, ships, and fixed stations.



Source: JTRS AMF Program Office.



Program Essentials

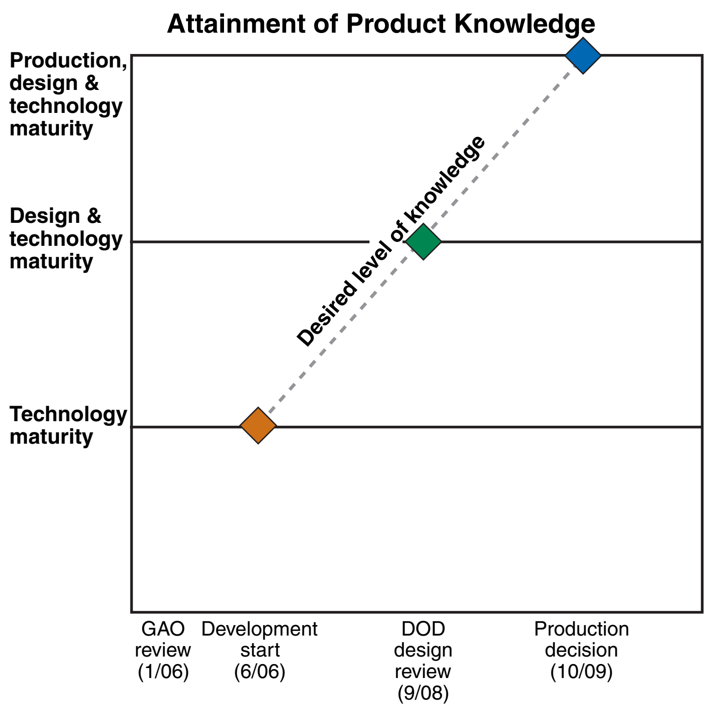
Prime contractor: TBD
Program office: Hanscom AFB, Mass.
Funding FY06-FY11:
- R&D: $842.6 million
- Procurement: $1,649.1 million
- Total funding: $2,545.4 million
- Procurement quantity: 3,261

Program Performance (fiscal year 2006 dollars in millions)

	As of NA	Latest 06/2005	Percent change
Research and development cost	NA	$1,027.7	NA
Procurement cost	NA	$1,649.1	NA
Total program cost	NA	$2,730.5	NA
Program unit cost	NA	TBD	NA
Total quantities	NA	3,338	NA
Acquisition cycle time (months)	NA	NA	NA

Costs and quantities reflect the program of record. Both are expected to change as a part of a program restructuring currently underway.

JTRS AMF has taken steps to develop knowledge prior to the start of system development. As part of the program's acquisition strategy, a pre-system development phase started in September 2004 with the award of competitive system design contracts to two industry teams led by Boeing and Lockheed Martin. Through this acquisition strategy, program officials expect competitive designs that will help mitigate costs and other risks. While challenges remain, program officials noted that significant progress has been made by both industry teams in demonstrating technology and design maturity. The program is scheduled to enter system development in June 2006. The JTRS Joint Program Executive Office is currently conducting a broad assessment of JTRS. The assessment may result in changes to the current JTRS AMF acquisition strategy.



JTRS AMF Program

Technology Maturity

To help mitigate technical risks and address key integration challenges, JTRS AMF awarded competitive predevelopment contracts to two industry teams led by Boeing and Lockheed Martin. In July 2006, after a full and open competition, a contracting team will be selected for the JTRS AMF system development. The program office will use an Army organization to prepare an independent Technology Readiness Assessment before entry into the system development and demonstration acquisition phase. The identification of critical technologies and the assessment of their respective maturities will not be available until the conclusion of the competitive system design contract work and the Technology Readiness Assessment is submitted by the independent assessment team. The competitive system design contract work will be completed in February 2006.

Although critical technologies have not been formally assessed for JTRS AMF, both teams have demonstrated progress in developing key functions of the radio, according to program officials. Preliminary design reviews were held in early August 2005 for both teams, and program officials indicated that both preliminary designs met the National Security Agency's information security requirements. Although the program is likely to face challenges as it proceeds through system development and demonstration, program officials are confident that the program can enter the system development and demonstration phase with sufficiently mature technology. This assurance is based on technical exchange and review meetings with the contractors, along with vigorous risk reduction programs by both the contractors and program office established during the pre-system development and demonstration contract.

Other Program Issues

The JTRS AMF is depending on the JTRS Cluster 1 program to develop the necessary waveforms. However, the JTRS Cluster 1 program is currently being restructured due to significant cost and schedule problems. As a result, the waveforms being developed under the Cluster 1 contract may not be developed in time or may not meet JTRS AMF user requirements which may negatively affect hardware design and cause an increase in cost and schedule.

Another issue the program office will need to address is the development of technologies necessary to effectively dissipate heat in some of its smaller radios. If cooling techniques are not improved, the performance of these radios will be limited. In addition, integrating the radios into the diverse platforms covered by JTRS AMF will be a challenge.

Because of the ongoing cost, schedule, and technical problems with the Cluster 1 program, the JTRS Joint Program Executive Office has begun a broader assessment of all JTRS clusters. At this point, it is unclear how the JTRS AMF program will be affected by the results of the broader assessment. Because of the progress made in the JTRS AMF program, DOD may expand the numbers and types of platforms on which it will be based. For example, JTRS AMF program officials noted that it is likely that the Army's rotary wing JTRS requirements will be moved from JTRS Cluster 1 to JTRS AMF. The JTRS Joint Program Executive Office developed several alternative acquisition strategies which were presented to the Defense Acquisition Board in November 2005.

Agency Comments

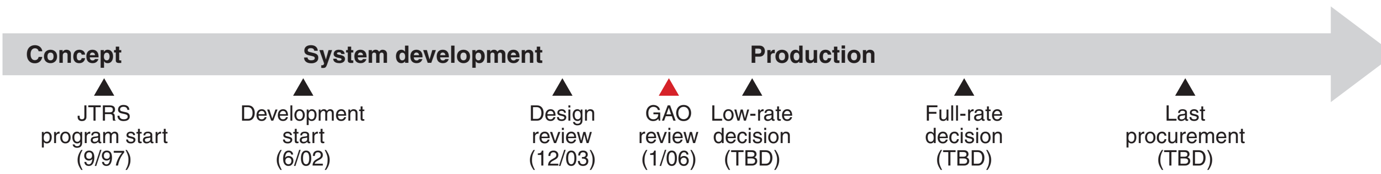
In commenting on our draft, the program office generally concurred with our findings and offered technical comments for our consideration. We incorporated the technical comments where appropriate.

In addition, the program office stated that the JTRS AMF program has managed the identified risks with mitigation plans and monitoring of the competing contractors' technical designs and their use of advanced technologies. The waveform dependency risk, for example, is being mitigated by the contractors' access to alternate waveform software that is similar in features to the Cluster 1 waveform system. The contractors have also focused considerable investment in addressing the heat dissipation of their designs and projected performance limits as a function of industry technology improvements, such as processor speeds or device sizes.

Joint Tactical Radio System (JTRS) Cluster 1

The JTRS program is developing software-defined radios that will interoperate with existing radios and also increase communications and networking capabilities. A Joint Program Executive Office provides a central acquisition authority and balances acquisition actions across the services, while product offices are developing radio hardware and software for users with similar requirements. The Army-led JTRS Cluster 1 product office, within the Ground Radio Systems program office, is developing radios for ground vehicles.

Source: PM WIN-T JTRS Cluster 1.



Program Essentials

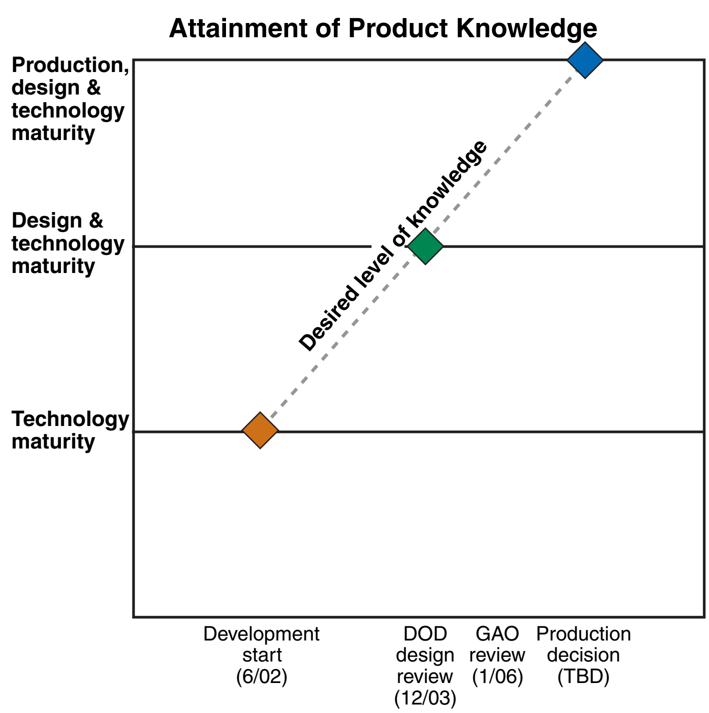
Prime contractor: Boeing
Program office: San Diego, Calif.
Funding needed to complete:
R&D: $619.1 million
Procurement: $14,815.6 million
Total funding: $15,434.8 million
Procurement quantity: 108,836

Program Performance (fiscal year 2006 dollars in millions)

	As of 06/2002	Latest 08/2005	Percent change
Research and development cost	$905.7	$1,188.8	31.3
Procurement cost	$14,568.2	$15,029.8	3.2
Total program cost	$15,473.9	$16,218.6	4.8
Program unit cost	$.143	$.148	3.4
Total quantities	108,388	109,921	1.4
Acquisition cycle time (months)	55	TBD	TBD

Costs and quantities reflect the program of record. Both are expected to change as part of the program's restructuring.

The JTRS Cluster 1 program is currently being restructured due to significant cost and schedule problems that came to light in late 2004. Since development began in 2002, the program has struggled to mature and integrate key technologies and been forced to make design changes. For example, the Cluster 1 design does not meet size, weight, and power constraints or security requirements to operate in a networked environment. The JTRS program restructure has been approved by the Defense Acquisition Executive and provides for a path forward to meet security requirements. Over the next year, the program will seek full approval of the strategy, targeted for early fiscal year 2007. Due to the program restructuring, we did not assess the current overall attainment of product knowledge.



JTRS Cluster 1 Program

Technology Maturity

The maturity of Cluster 1's critical technologies is unclear. The program reported that 13 of its 20 critical technologies were mature indicating that progress has been made since the program entered system development in 2002 when none of the program's critical technologies were mature. However, this progress is based on a series of contractor demonstrations conducted in spring 2005 that used only partially functioning prototypes. A planned operational assessment was canceled after the Army informed the contractor of possible contract termination. Among other things, the demonstrations did not show extensive Wideband Networking Waveform capabilities. The Wideband Networking Waveform represents the core of the JTRS networking capability and its integration is the most significant technical challenge to the radio's development, according to program officials. In addition, critical technologies such as the network bridging software are immature. Moreover, the program continues to be challenged by security requirements. The program has identified an interim approach to address security requirements that complies with National Security Agency guidance and supports the operation of networking waveforms and interoperability with non-JTRS networks. However, the approach utilizes only partially functioning prototypes and is expected to provide only limited capabilities. Program officials noted that a follow-up effort involving actual prototypes will provide full capabilities. Until the program demonstrates an actual prototype under realistic conditions and completes its restructuring of the program, it is difficult to evaluate the maturity of its critical technologies.

Design Stability

The program reports achieving design stability for the basic Cluster 1 radio design. However, the National Security Agency has determined that the current design is not sufficient to meet newly discovered security requirements needed to operate in an open networked environment. The program also continues to reconcile size, weight, and power requirements. These challenges and the uncertainty of technology maturity raise concern about the program's design stability.

Other Program Issues

In light of the technical problems and cost growth, the Office of the Secretary of Defense in January 2005 directed the Army to stop work on portions of the Cluster 1 development. In April 2005, the Army notified the prime contractor that it was considering contract termination. This action was taken based on initial findings of an assessment of the Cluster 1 program conducted by the newly established JTRS Joint Program Executive Office, which concluded that the current program was not executable and the contractor's ability to develop the radio was questionable. Despite these concerns, the partial stop work order was allowed to expire, and the prime contractor was allowed to continue portions of the Cluster 1 contract.

The JTRS Joint Program Executive Office is now proceeding with a major restructuring of the program. It has completed its assessments of the JTRS clusters, revising the programs' management and financial structure and has reviewed Cluster 1 requirements with the intent of making the program more achievable. The JTRS Joint Program Executive Office developed several acquisition strategies which were presented to the Defense Acquisition Board in October and November 2005. The JTRS restructure has been approved by the Defense Acquisition Executive, and the program will seek full approval of the strategy over the next year. Program officials expect the restructured program to be up and running in early fiscal year 2007. In the meantime, the program continues to mature and support prototype design. The restructured program will emphasize an evolutionary acquisition of the radio in increments rather than attempting to field a complete capability all at once. In addition, DOD officials expect that the development of the helicopter variant will be moved to the JTRS Airborne, Maritime and Fixed-Site program.

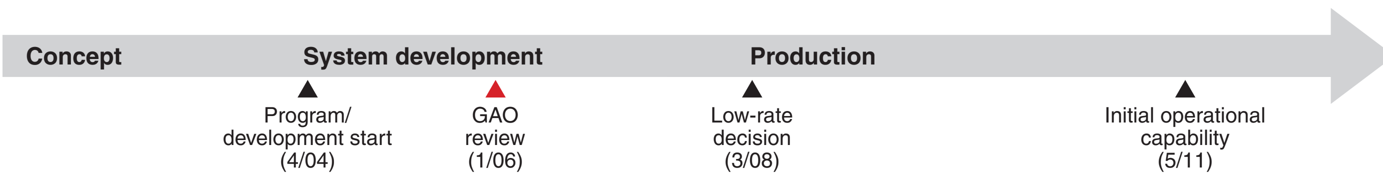
Agency Comments

In commenting on a draft of this assessmnet, the program office generally agreed with the information provided in this report. Program offcials also provided technical comments, which were incorporated where appropriate.

Joint Tactical Radio System (JTRS) Cluster 5

The JTRS program is developing software-defined radios that will interoperate with existing radios and also increase communications and networking capabilities. A Joint Program Executive Office provides a central acquisition authority and balances acquisition actions across the services, while product offices are developing radio hardware and software for users with similar requirements. The Army-led JTRS Cluster 5 product office, within the Ground Radio Systems program office, is developing handheld, manpack, and small embeddable radios.

Source: PM WIN-T JTRS Cluster 5.



Program Essentials

Prime contractor: General Dynamics C4 Systems
Program office: Ft. Monmouth, N.J.
Funding needed to complete:
R&D: $341.0 million
Procurement: $8,431.1 million
Total funding: $8,772.2 million
Procurement quantity: 328,514

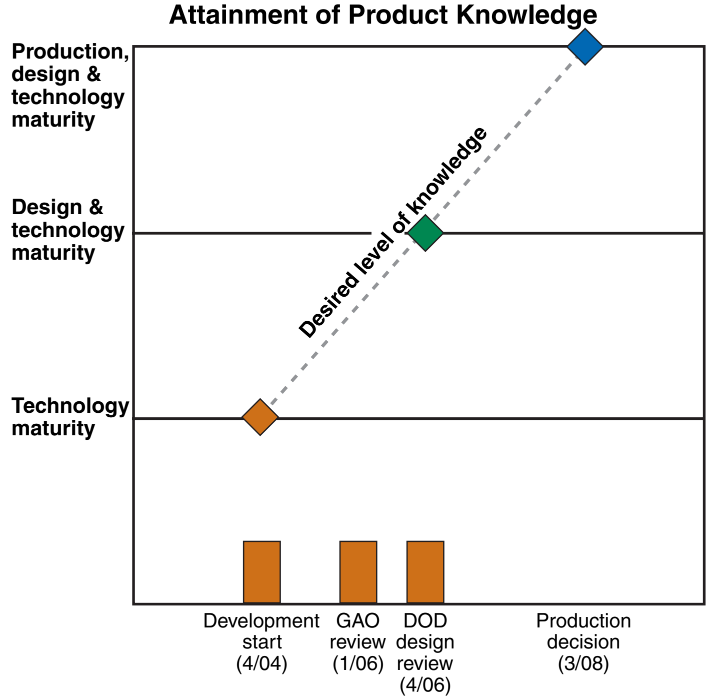
Program Performance (fiscal year 2006 dollars in millions)

	As of 05/2004	Latest 08/2005	Percent change
Research and development cost	$483.8	$483.8	0.0
Procurement cost	$8,431.1	$8431.1	0.0
Total program cost	$8,914.9	$8,914.9	0.0
Program unit cost	$.027	$.027	0.0
Total quantities	329,574	329,574	0.0
Acquisition cycle time (months)	85	85	0.0

Costs and quantities reflect the program of record. Both are expected to change as a part of a program restructuring currently underway.

JTRS Cluster 5 began system development with one of its six critical technologies considered mature. The program considers the five other technologies low risk and anticipates increased levels of maturity, though not full maturity, by the production decision in March 2008. We did not assess design stability because no production representative drawings had been released at the time of our assessment. The total number of drawings has also not been identified. The JTRS Joint Program Executive Office has conducted a broad assessment of the entire JTRS program. A JTRS program restructure has been approved by the Defense Acquisition Executive. The program will seek full approval of the revised strategy by the start of fiscal year 2007. The revised Cluster 5 program is described as a moderate risk program.

Attainment of Product Knowledge



JTRS Cluster 5 Program

Technology Maturity

The JTRS Cluster 5 program has identified six critical technologies and is focused on a common set of core circuit card assemblies for all its handheld, manpack, and small form factor radios. The program office has assessed one of the Cluster 5 critical technologies, termed environmental protection, as mature for use. The program office has assessed two other critical technologies, antenna and power management, at a high level of readiness, although not fully mature. However, the power management technology may not be as mature as assessed given the Cluster 5 requirement to support a JTRS Wideband Networking Waveform. This waveform is essential to providing JTRS networking services to ensure interoperability over a wide range of frequencies. While it is not designated a Cluster 5 critical technology, the JTRS Operational Requirements Document designates it as a key performance parameter. Operation of this waveform carries with it a large power requirement. Because of the technical challenges of meeting that power requirement in an acceptable size and weight, the Cluster 5 program is seeking some relief from the waveform's requirements and attempting to optimize the software code to increase its power efficiency. It is also evaluating alternative waveforms such as the Soldier Radio Waveform to provide in a power efficient way the needed networked services for radios with highly constrained power and antenna size. The remaining Cluster 5 critical technologies--microelectronics, multichannel architecture, and security--require additional development. According to the program office, however, all three represent a moderate level of risk and are anticipated to reach increased levels of maturity by the production decision.

The program continues to address size, weight, and power requirements. The Cluster 5 two-channel manpack radios are to have a maximum weight of 9 pounds. In comparison, current single channel manpack radios weigh in excess of 13 pounds. However, the JTRS Joint Service Capabilities Working Group recently gave the program relief in meeting this weight requirement.

Design Stability

We did not assess the design stability of JTRS Cluster 5 because the total number of drawings is not known and there are currently no releasable drawings complete.

Other Program Issues

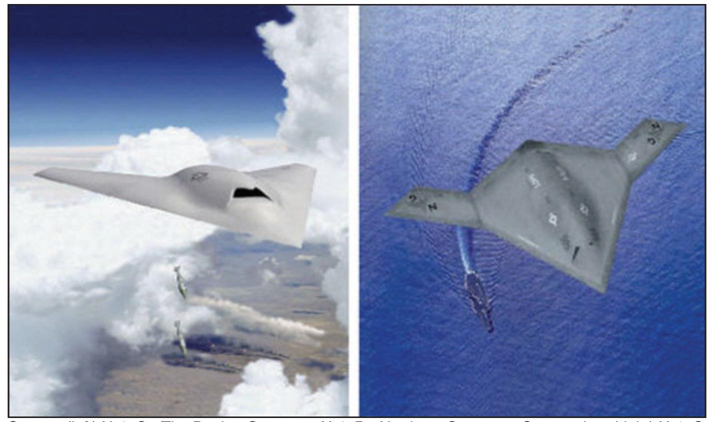
In authorizing the Cluster 5 program to begin system development in April 2004, the Army Acquisition Executive directed that the program assess the technological maturity of its plans for acquiring Future Combat System unique small form factor JTRS capability. This review was scheduled for spring 2005. However, in February 2005 the newly appointed JTRS Joint Program Executive Officer assumed responsibility for all JTRS Clusters, including Cluster 5, and began an assessment of all JTRS Clusters. Based on this assessment, the JTRS Joint Program Executive Office developed several alternative acquisition strategies which were presented to the Defense Acquisition Board in October and November 2005. The restructured program will emphasize developing and evolving the radio products in increments rather than attempting to field a complete capability all at once. According to program officials, delivering a JTRS capability in increments will make the JTRS Program executable and reduce cost, schedule, and performance risk.

Agency Comments

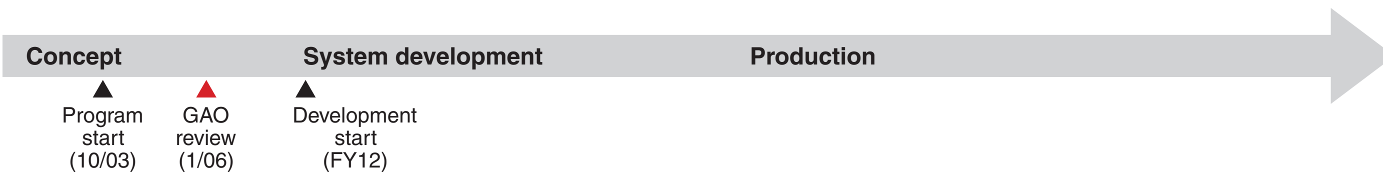
In commenting on our draft, the program office generally concurred with our findings and offered technical comments for our consideration. Many of the technical comments involved updated information on the status of the JTRS restructuring. We incorporated all relevant updated information into our report.

Joint Unmanned Combat Air Systems (J-UCAS)

The J-UCAS program is a joint Air Force and Navy effort to develop and demonstrate the technical feasibility and operational value of a networked system of high performance, weaponized unmanned aircraft. Planned missions include suppression of enemy air defenses, precision strike, persistent surveillance, and potentially others such as electronic attack as resources and requirements dictate. The program consolidates two formerly separate service efforts and is to develop and demonstrate larger, more capable, and interoperable aircraft.



Source: (left) X-45C - The Boeing Company, X-47B - Northrop Grumman Corporation, (right) X-45C © 2004 The Boeing Company, X-47B © 2004 Northrop Grumman Corporation.



Program Essentials

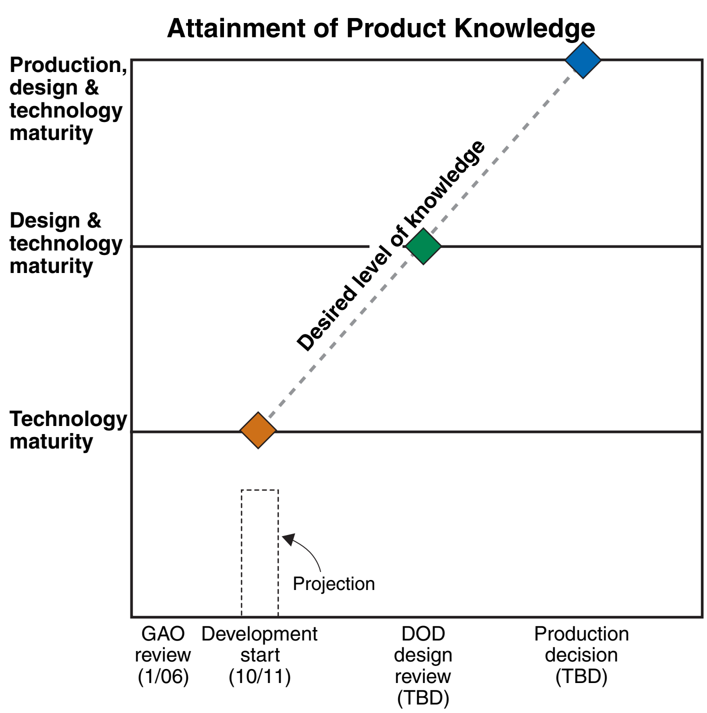
Prime contractor: Boeing, Johns-Hopkins Univ. Applied Physics Lab, Northrop Grumman
Program office: Dayton, Ohio
Funding, FY06-FY12:
R&D: $3,876.7 million
Procurement: $0.0 million
Total funding: $3,876.7 million
Procurement quantity: 0

Program Performance (fiscal year 2006 dollars in millions)

	As of 09/2004	Latest 08/2005	Percent change
Research and development cost	$4,151.4	$2,898.9	-30.2
Procurement cost	$0.0	$0.0	0.0
Total program cost	$4,151.4	$2,898.9	-30.2
Program unit cost	$691.900	$579.780	-16.2
Total quantities	6	5	-16.7
Acquisition cycle time (months)	TBD	TBD	TBD

Costs and quantities are budgeted amounts from the joint program's inception in fiscal year 2004 through fiscal year 2009. Total known program cost through fiscal year 2012 is $4,792.5 million.

None of the eight critical technologies for this pre-acquisition program are currently mature, but J-UCAS officials project that, due primarily to planned risk reduction efforts, three will be mature and five will be approaching maturity to support a potential system acquisition start in fiscal year 2012. The J-UCAS program has been buffeted by frequent changes in leadership, funding, and priorities. Leadership recently transitioned from the Defense Advanced Research Projects Agency to the Air Force with Navy participation and funding was reduced. The Quadrennial Defense Review then recommended restructuring the J-UCAS program to develop a longer-range carrier-based unmanned combat aircraft for the Navy. The Air Force plans to consider J-UCAS technologies and accomplishments in its efforts to develop a new long-range persistent strike capability.



J-UCAS Program

Technology Maturity

None of the eight critical technologies identified for this pre-acquisition program are currently mature. Technologies include adaptive autonomous operations (for controlling groups of aircraft flying in a coordinated manner without human inputs) and force integration (for interoperating with intelligence sources and strike and surveillance packages). Most technologies are in a maturity range in which basic components are integrated to establish they will work together and components are integrated with reasonably realistic support elements for testing in a simulated environment.

J-UCAS program officials have established a structured and disciplined framework for maturing technologies, using both in-house efforts and technology developments outside the program. Officials project that, at a potential system start-up in fiscal year 2012, three technologies will be mature at the best practices standard and the remaining five will be approaching maturity.

As currently envisioned, the J-UCAS program will develop technologies and operationally assess demonstrator aircraft from two prime contractors sharing a common operating system, payloads, and subsystems. Boeing X-45, Northrop-Grumman X-47, and common systems and techologies are on contracts and proceeding forward. The Air Force and Navy could then use the results of the operational assessment to decide whether to start system development program(s).

Other Program Issues

The just-completed Quadrennial Defense Review recommended restructuring the J-UCAS program and develop an unmanned longer-range carrier-based aircraft to increase naval reach and persistence. The Air Force is focusing its resources on delivering a new long-range strike capability. Officials will consider J-UCAS technologies and accomplishments in the analysis of alternatives for the new strike capability. Final decisions, future plans, and funding requirements were not available to us at the time of our review.

Prior to the Quadrennial Defense Review, the J-UCAS program had already undergone several changes in leadership, program direction and priorities, and funding. Recognizing the potential for synergy and cost savings, OSD consolidated separate Air Force and Navy efforts in a joint program in October 2003 under DARPA leadership. The previous service efforts had been targeted to specific service needs and different missions; under the joint program, the emphasis was on developing interoperable and networked systems utilizing a common operating system, sensors, and weapons. A December 2004 program budget decision by OSD reduced future budgets, directed a restructure to emphasize development of air vehicles, and directed that management be transitioned to the Air Force with Navy participation; this was accomplished in November 2005.

Congress reduced funding in the 2005 and 2006 budget requests. For 2005, Congress expressed concerns that the joint program had not properly coordinated with the two services and directed that the technology demonstrators be completed in support of Air Force and Navy requirements. For 2006, Congress expressed concerns about fluctuations in the program, including Service ownership, and apparent incompatibility of the Air Force and Navy requirements. The Congress also directed DOD to conduct an independent study to review technical requirements and options for cost savings, and to provide an analysis and recommendation on whether the Air Force and Navy are sufficiently different in their respective requirements and level of development to merit separation into service-unique programs.

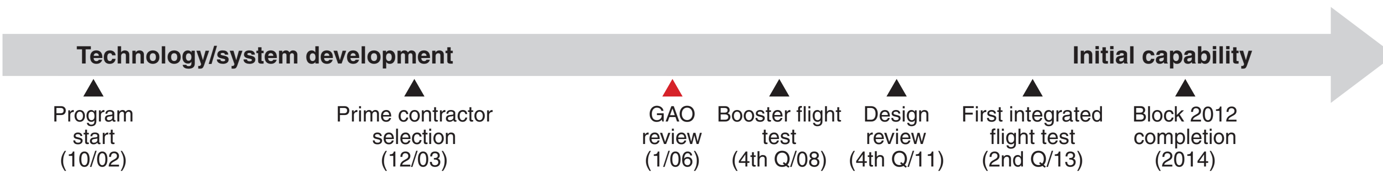
Agency Comments

In commenting on a draft of this assessment, DOD said that all critical technologies are projected to be mature enough to support start of system development expected in fiscal year 2012. Subsequently, J-UCAS program officials briefed us on the process and results of a new reassessment of technology maturity levels. We updated this product to reflect the reassessment and incorporated current events from the Quadrennial Defense Review.

Kinetic Energy Interceptors (KEI)

MDA's KEI element is a missile defense system designed to destroy medium, intermediate, and intercontinental ballistic missiles during the boost and midcourse phases of flight. Key components include hit-to-kill interceptors, mobile launchers, and fire control and communications units. We assessed the proposed land-based KEI capability, which according to program officials, will be available in 2014.

Source: Kinetic Energy Interceptors Program Office, Northrop Grumman.



Program Essentials

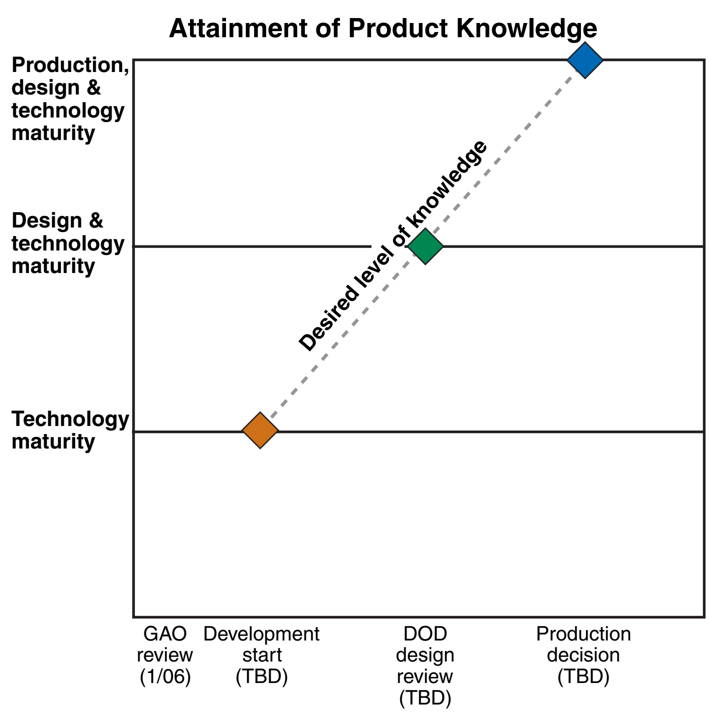
Prime contractor: Northrop Grumman
Program office: Fairlakes, Va.
Funding FY06-FY11:
- R&D: $5,137.3 million
- Procurement: $0.0 million
- Total funding: $5,137.3 million
- Procurement quantity: 0

Program Performance (fiscal year 2006 dollars in millions)

	As of 09/2003	Latest 08/2005	Percent change
Research and development cost	$8,791.5	$2,838.2	-67.7
Procurement cost	$0.0	$0.0	0.0
Total program cost	$8,791.5	$2,838.2	-67.7
Program unit cost	TBD	TBD	TBD
Total quantities	NA	8	NA
Acquisition cycle time (months)	NA	TBD	NA

Table reflects known costs of program from program inception through fiscal year 2009. Procurement cost has yet to be determined. Total known cost through fiscal year 2011 is $5,678.0 million.

KEI's seven critical technologies are at a relatively low level of maturity, with two rated as high risk--the interceptor's booster motors and the algorithm that enables the kill vehicle to identify the threat missile's body from the luminous exhaust plume. According to MDA officials, integration issues and hardware manufacturability are being addressed, and the design of the demonstration hardware should become the design for the operational KEI element. In 2008, MDA will assess KEI's achievements and decide how the program should proceed. If a decision is made to move forward, MDA plans to finalize the design during the fourth quarter of fiscal year 2011. At that time, two technologies will have been demonstrated in flight tests, and four in ground tests. KEI underwent a replan to compensate for fiscal year 2005 funding cuts and additional requirements, causing program delays.



KEI Program

Technology Maturity

All seven KEI critical technologies are at a relatively low level of maturity. These technologies are part of the element's interceptor, the weapon component of the element consisting of a kill vehicle mounted atop a boost vehicle. Of the seven technologies, four pertain to the boost vehicle that propels the kill vehicle into space. Boost vehicle technologies include two types of booster motors, an attitude control system, and a thrust vector control sytem. The remaining three technologies are related to the kill vehicle--its infrared seeker, divert system, and plume-to-hardbody algorithms. Although all technologies are immature, three of the seven are new applications of existing technologies developed by other missile defense programs. The infrared seeker and the third stage rocket motor come from the Aegis BMD program, and the divert system comes from the GMD program. Backup technologies exist for all technologies, but the infrared seeker. However, these technologies are at the same low level of maturity as the critical technologies.

Program officials noted that they expect the design of the demonstration hardware to be the design of the operational hardware. Therefore, integration and manufacturability issues are being addressed in the design of the demonstration hardware. According to program officials, KEI's operational design will be finalized in 2011. By that time, MDA plans to demonstrate two critical tecnologies--the thrust vector control system and one of the two types of boosters--in two booster flight tests. Other technologes will have been demonstrated in ground tests, such as hardware-in-the-loop tests and flight tests. The integration of all critical technologies will be demonstrated in an element characterization test early in fiscal year 2012, a sea risk reduction flight test in late 2012, followed by the first integrated flight test early in 2013.

Design Stability

The KEI program office estimates that KEI's design will incorporate about 7,500 drawings. Program officials expect 5,000 of these drawings to be complete when it holds a critical design/production readiness review for the land-based capability in 2009. However, it is too early to make an accurate assessment of KEI's design because all of KEI's technologies are not mature. In addition to using the number of drawings released as a measure of the design's maturity, the program also plans to use Engineering and Manufacturing Readiness Levels to determine the design's manufacturability and Software Readiness Levels to assess the maturity of KEI's software.

Other Program Issues

In fiscal year 2008, MDA plans to assess KEI's accomplishments and make decisions about the program's future. If MDA decides to acquire KEI, program officials expect to begin development of a space-based test bed. MDA expects to expend about $673 million between fiscal years 2008 and 2011 on the test bed's development, which, when complete, is envisioned as a limited constellation of space based interceptors capable of providing an additional layer of defense against ICBMs. In spite of its unknown future, program officials are working to extend KEI's contract from January 2012 (98 months) to September 2015 (143) months. Additionally, the program has directed its contractor to investigate the effect of making KEI capable of defeating threat missiles during the midcourse of their flight.

The KEI program underwent a program replan to compensate for fiscal year 2005 funding cuts and the addition of new requirements, such as a requirement for nuclear hardening imposed by MDA. Under the replan the Block 2010 land-based capability was combined with the Block 2012 sea-based capability, both of which utilize the same interceptor. According to program officials, KEI is undergoing further restructuring which has delayed the land-based capability into Block 2014 and the sea-based capability into Block 2016. Program officials noted that if they receive additional funding, the land-based capability could still be delivered during Block 2012.

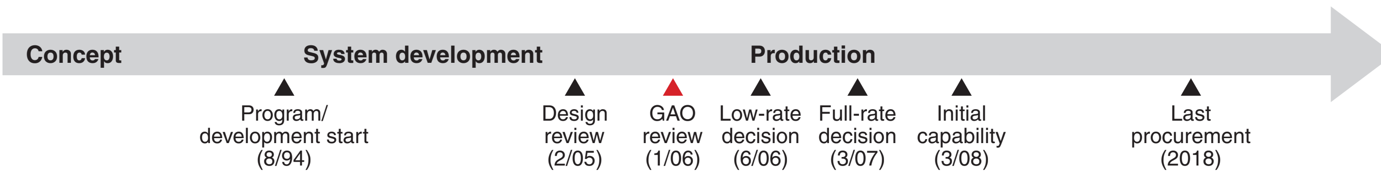
Agency Comments

MDA provided technical comments, which were incorporated where appropriate.

Land Warrior

The Army's Land Warrior program is developing modular, integrated, soldier-worn systems intended to enhance the lethality, situational awareness, and survivability of dismounted combat and support soldiers. The program restructured in 2005 in an effort to field capability to the current force, focusing on the Dismounted Battle Command System (DBCS). DBCS comprises the Commander's Digital Assistant and the MicroLight Enhanced Position Location and Reporting System, elements of the previously planned Land Warrior system. We assessed DBCS.

Source: Program Executive Office Soldier.



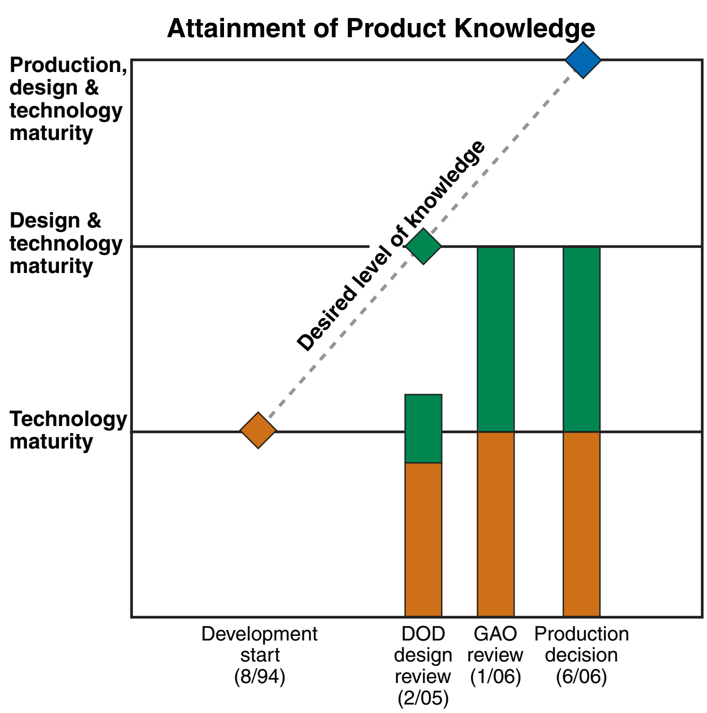
Program Essentials

Prime contractor: General Dynamics
Program office: Fort Belvoir, Va.
Funding needed to complete:
R&D: $438.5 million
Procurement: $8,255.8 million
Total funding: $8,694.2 million
Procurement quantity: 84,658

Program Performance (fiscal year 2006 dollars in millions)

	As of 02/2003	Latest 12/2004	Percent change
Research and development cost	$779.3	$1,010.0	29.6
Procurement cost	$1,822.2	$8,264.7	353.5
Total program cost	$2,601.5	$9,274.6	256.5
Program unit cost	$.163	$.109	-33.3
Total quantities	15,985	85,412	434.3
Acquisition cycle time (months)	145	163	12.4

As an early spiral of Land Warrior, the Dismounted Battle Command System is technologically less ambitious than previous efforts. The system's three critical technologies (power, radio communications, and the personal area network) are mature; however, the personal area network that connects the components together did not reach maturity by the time of the DBCS critical design review in February 2005. The program did not achieve design stability by this design review, but all drawings are currently releasable. We could not assess production maturity for DBCS because the program is not collecting statistical process control data at this time. However, the results of an early evaluation of DBCS conducted by the Army Test and Evaluation Command in August 2005 recently led the Army to terminate the DBCS effort and focus on developing the full Land Warrior ensemble.



Land Warrior Program

Technology Maturity

An early spiral of Land Warrior, DBCS is intended to provide a limited, near-term capability to the current force to improve infantry unit battle command and situational awareness. As a partial capability, DBCS is technologically less ambitious than the system we assessed last year. The DBCS comprises two adapted commercially available components: the Commander's Digital Assistant (CDA) and the MicroLight Enhanced Position Location Reporting System (EPLRS). Running the Army's Force XXI Battle Command Brigade and Below situational awareness software, the CDA is intended to provide leaders at the platoon and company level with blue (friendly) force tracking capability. The MicroLight EPLRS will provide voice and data communications at the squad level and higher. The three critical technologies for DBCS, radio communications (the MicroLight EPLRS), power for the CDA (batteries), and the personal area network that connects the components together, are mature by best practice standards.

We did not assess technology maturity for the limited number of full Land Warrior ensembles the Army is procuring for assessment purposes in 2006. Last year we assessed what was then Block II of the program, the Land Warrior--Stryker Interoperable system. At that time, two of the system's four critical technologies were not mature (the personal area network and radio communications). The Land Warrior system will eventually use the JTRS Cluster 5 embedded radio (assessed elsewhere in this report), scheduled to be available in fiscal year 2011.

Design Stability

The program reported that 23 design drawings out of a total expected number of 70 were releasable at the February 2005 critical design review for DBCS, and that all 70 drawings are currently releasable.

Production Maturity

We could not assess the maturity of production processes for DBCS because the program is not collecting statistical process control data at this time. Officials told us that while General Dynamics has not fully identified the key manufacturing processes, the company has initiated manufacturing planning in accordance with ISO 9000 guidelines.

Other Program Issues

The Army restructured the program in 2005 in response to congressional direction to immediately field some Land Warrior capabilities to the current force, terminating the Block II effort that was underway. The restructured program comprised three phases. The first phase was focused on fielding the Dismounted Battle Command System to leaders of up to 30 of the Army's Brigade Combat Teams. The Army conducted an early evaluation of DBCS in August 2005, during which soldiers from the 10th Mountain Division used the system in training for an upcoming deployment to Afghanistan. The Army Test and Evaluation Command concluded that DBCS was not suitable for light infantry operations and reported that the system's weight and physical configuration reduced soldiers' mobility. In addition, the demonstration revealed concerns about power consumption as well as an inability to interoperate with the unit's existing radios. Noting that the unit would not take DBCS to Afghanistan, DOD's Director of Operational Test and Evaluation concluded that the system did not demonstrate the necessary capabilities and that the current system was not mature.

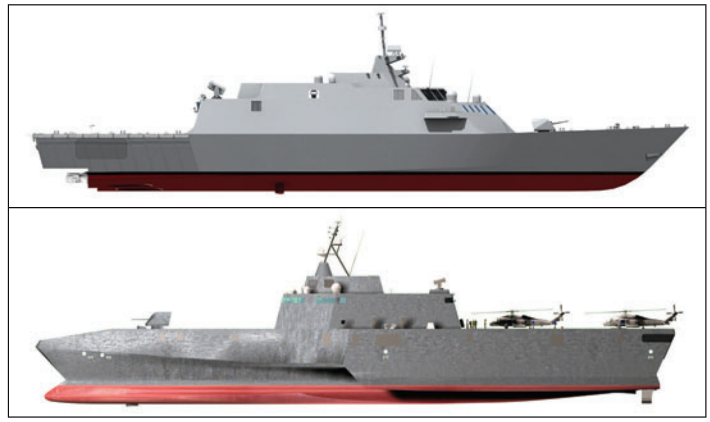
The second phase of the program, still on track, is focused on developing an integrated Land Warrior capability in support of the Army's Stryker Brigades. Slightly less capable than the system we assessed last year, the program plans to field 486 of these systems to one Stryker battalion in fiscal year 2006 for assessment purposes. The third phase, Ground Soldier System, is the future iteration of Land Warrior capability intended to provide a dismounted soldier capability to the Army's Future Combat Systems. In early 2005, the program completed a plan to consolidate the Land Warrior program with the Army's Future Force Warrior Advanced Technology Demonstration effort.

Agency Comments

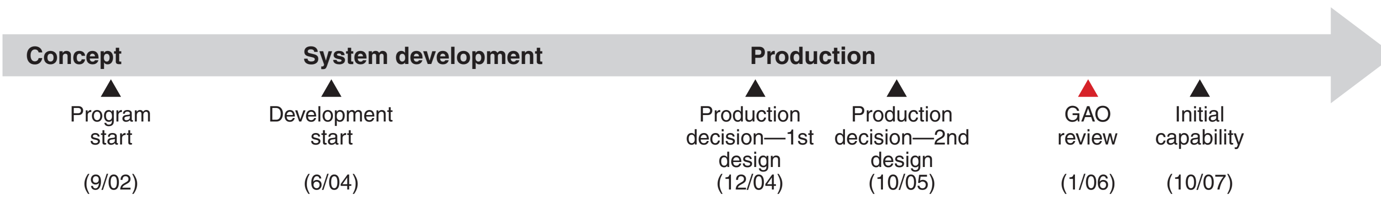
In commenting on a draft of this assessment, the Army provided technical comments, which were incorporated where appropriate.

Littoral Combat Ship (LCS)

The Navy's LCS is to be a surface combatant optimized for littoral warfare with innovative hull designs and reconfigurable mission packages to counter threats in three mission areas: mine, antisubmarine, and surface warfare. The ship and mission packages are being developed in spirals with the first four ships, Flight 0, produced in two designs. We assessed only Flight 0 ships and their associated mission packages.



Source: (top) Lockheed Martin, (bottom) General Dynamics.



Program Essentials

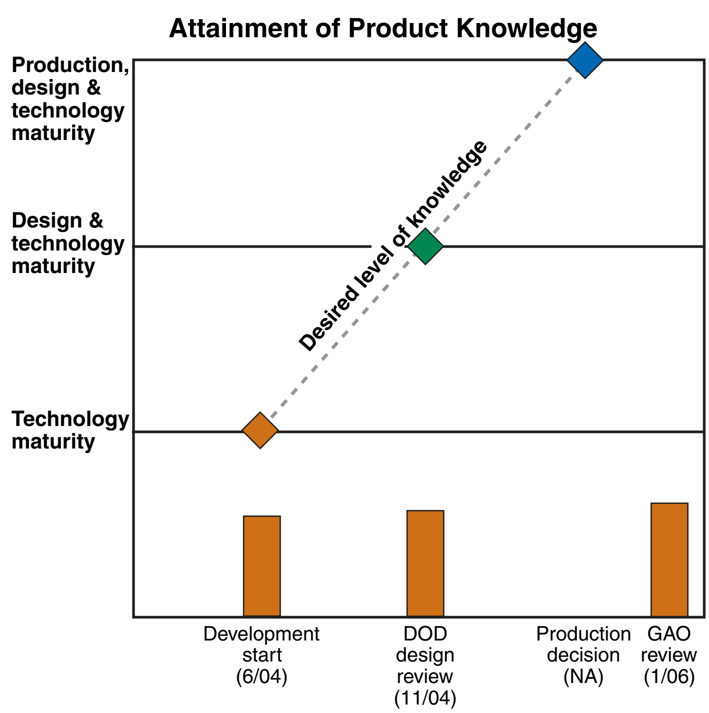
Prime contractor: General Dynamics, Lockheed Martin
Program office: Washington, D.C.
Funding needed to complete:
- R&D: $654.4 million
- Procurement: $592.0 million
- Total funding: $1,246.4 million
- Procurement quantity: 2

Program Performance (fiscal year 2006 dollars in millions)

	As of 05/2004	Latest 08/2005	Percent change
Research and development cost	$1,220.0	$1,315.5	7.8
Procurement cost	$0.0	$590.6	NA
Total program cost	$1,220.0	$1,906.2	56.2
Program unit cost	$610.019	$476.540	-21.9
Total quantities	2	4	100.0
Acquisition cycle time (months)	41	29	-29.3

Two of the ships will be procured using research and development funds. Quantity shown is the number of ships procured, seven mission packages will also be procured with funds shown.

The LCS program entered system development in June 2004. The program office identified 41 critical technologies for the mission packages and 43 technologies between the two ship designs. Since our last review, LCS has continued to test and mature its technologies for the mission packages. Currently 19 of the 41 mission package technologies are fully mature; seven are near full maturity; and 15 remain in development. The technologies that have not reached maturity affect all three of the mission packages, each of which will go through critical design review in 2006. The majority of technologies for the ship designs are fully mature or near maturity, except for those used for launch and recovery or command and control of off-board vehicles. Both ship designs have begun production.



LCS Program

Technology Maturity

Nine of the technologies under development for LCS are used in multiple applications or mission packages. Since these technologies are used on different platforms or in different environments, the program office chose to assess them in each setting separately. This results in a total of 41 critical technologies, 19 of which are currently mature.

The first mine warfare mission package will align with delivery of the first ship in January 2007. In this mission, the MH-60S helicopter is to carry subsystems for either detection or neutralization of mines. A key component for attaching subsystems to the helicopter is currently undergoing flight testing to correct deficiencies. Delay of the MH-60 could leave gaps in the ability to detect some mines while increasing the time needed to neutralize others. The unmanned surface vehicle has a similar mine neutralization capability as the MH-60S, which also acts as its fallback. Neither the vehicle nor its payload is currently mature, and failure to deploy it on LCS will lead to increased use of the MH-60S. For mine warfare the vertical tactical unmanned autonomous vehicle, an unmanned helicopter, will employ the coastal battlefield reconnaissance and analysis system for detection of mines on the beach. Both the vehicle and its payload are currently immature, and no fallback is available to LCS.

The first antisubmarine and surface warfare packages will align with delivery of the second LCS in fiscal year 2008. The MH-60R helicopter, fully mature in each configuration, is critical for these missions. Antisubmarine and surface warfare will also be performed by a number of other immature systems, including the vertical tactical unmanned autonomous vehicle and the unmanned surface vehicle. The MH-60R is the fallback for those systems should they fail to mature. As a consequence, reliance on helicopters will increase should the unmanned systems fail to deploy with LCS.

Demonstration of mission package technologies will continue through 2008 and includes experiments with surrogate platforms. All technologies are expected to reach maturity by delivery of their respective mission package.

While the designs of the first LCS ships are novel in the experience of the Navy, the majority of ship-specific technologies are mature or close to full maturity. The Lockheed Martin design, the first to be produced, currently has 16 of 21 technologies mature or close to full maturity. The General Dynamics design currently has 20 of 22 technologies mature or close to full maturity. Most of the immature technologies are used to launch and recover or control the vehicles used in mission packages.

Design Stability

Design of mission packages is tracked in a unique manner as some of the "technologies" used are fully developed systems. These systems are being designed and produced by other programs and, to ensure that the mission packages will be compatible with LCS, the program has established a set of interface specifications that each system must meet. These specifications regulate issues like electrical, communications, and maintenance needs. The specifications for components of mission packages will be reviewed as part of a critical design review for each warfare package. Both designs of the first spiral of LCS ships have begun production. Application of commercial design specifications and standards to Navy shipbuilding have created some challenges during the design process, as has leveraging designs with commercial lineage for military use.

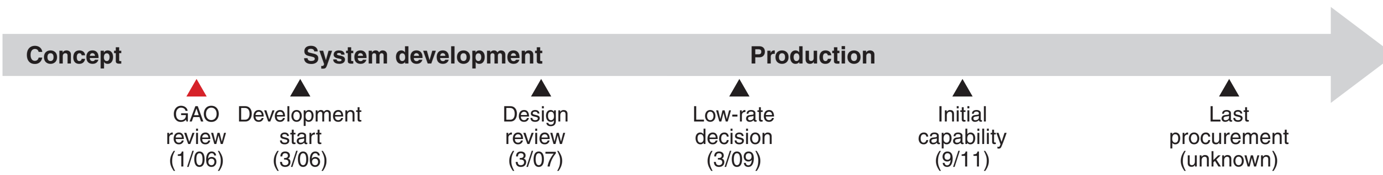
Agency Comments

In commenting on the draft of this assessment, the Navy stated that the LCS program implements spiral development to rapidly field capabilities that fill current operational gaps while achieving unprecedented flexibility for the future. Efficient spiral implementation is achieved through modular mission packages operated through a common interface specification. Mission package systems have been selected from best "state of the practice" technologies to satisfy requirements, ranging from mature acquisition programs to technology demonstrators. While component systems may be technically mature, repackaging and integration into operational mission packages requires verification testing to validate performance. Program test plans include specific events to rapidly demonstrate the technical maturity of the modular systems, and the flexibility of the modular open architecture greatly reduces the risk and impact from any single component.

Longbow Apache Block III

The Army's AH-64D Longbow Apache can be employed day or night, in adverse weather and obscurants, and is capable of engaging and destroying advanced threat weapon systems. The primary targets of the aircraft are mobile armor and air defense units, with secondary targets being threat helicopters. Block III enhancements are to ensure the Longbow Apache is compatible with the Future Combat System architecture, is a viable member of the future force, and is supportable through 2030. We assessed the Block III portion of the Apache.

Source: Boeing; Army Systems Program Office; Huntsville, AL.



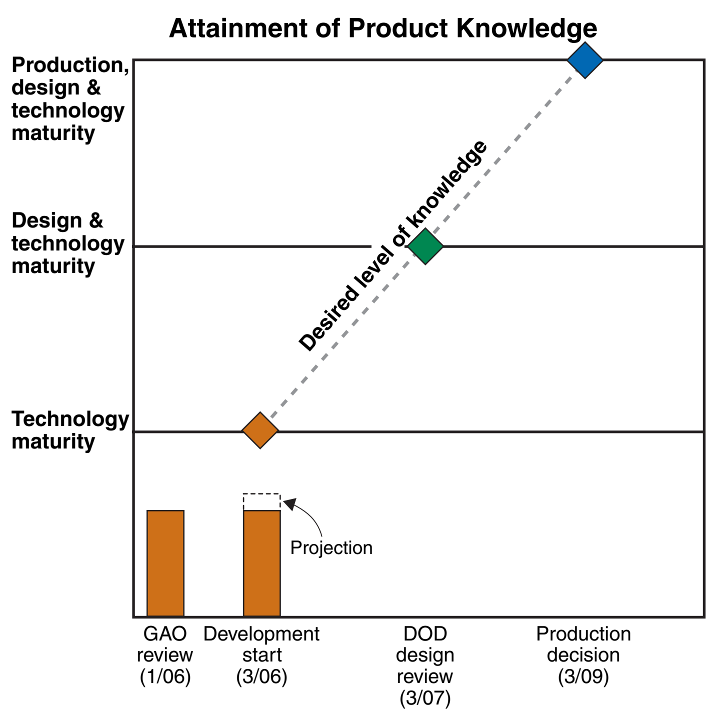
Program Essentials

Prime contractor: Boeing
Program office: Huntsville, Ala.
Funding needed to complete:
R&D: $714.9 million
Procurement: $1,159.2 million
Total funding: $1,874.1 million
Procurement quantity: 110

Program Performance (fiscal year 2006 dollars in millions)

	As of NA	Latest 08/2005	Percent change
Research and development cost	NA	$772.2	NA
Procurement cost	NA	$1,159.3	NA
Total program cost	NA	$1,931.6	NA
Program unit cost	NA	$17.560	NA
Total quantities	NA	110	NA
Acquisition cycle time (months)	NA	66	NA

The Apache Block III program plans to begin system development in March 2006 with approximately 67 percent of its critical technologies fully mature. However, while the Army plans to develop the Block III in one acquisition program, it also plans for the program to be comprised of two development phases. The Army expects to approve funding for the first phase in 2006 and the second after 2010. Overall, program officials project that at the start of development seven of the fifteen critical technologies will be fully mature, six approaching full maturity, and two immature. Due to the acquisition strategy and budgetary constraints, no further efforts to mature the less-than-fully mature technologies will occur until fiscal years 2010 to 2015. According to the program, these technologies are primarily software upgrades that will be easy to retrofit into helicopters.



Longbow Apache BLIII Program

Technology Maturity

Program officials report that 6 of 15 critical technologies are currently fully mature. Further, when the program enters the system development and demonstration phase in March 2006, an additional technology--the Level 4 Unmanned Aerial Vehicle Control--will have reached full maturity. These mature technologies are planned for insertion in the helicopter in the initial production lots. For example, the composite main rotor blade and the modernized signal processor units are already fully mature and will be incorporated in the 2010 to 2012 time frame. Due to the acquisition strategy and budgetary constraints, no further efforts to mature the 8 immature technologies will occur until fiscal years 2010 to 2015. As aircraft come off the production line, the program will have provisions in place that will allow for these technologies to be inserted when they are fully mature and available in the 2015 time frame.

Technical insertions for the Apache Block III effort consist of two general categories: processor upgrades and non-processor upgrades. The first development phase addresses some of the processor upgrades and all of the non-processor upgrades. The second developmental effort addresses the remaining processor upgrades. The processor upgrades are open or partitioned software architectures that will allow integration of most of the improvements. Processor upgrades include changes to the Instrument Flight Rules, the Modernized Signal Processor, the Radar Frequency Interferometer, the Control of Unmanned Aerial Vehicles, the Cognitive Decision Aiding System, the Fire Control Radar Range Extension, the Multi-Mode Laser, Aided Target Detection and Classification, Maritime Targeting Modes, and the Radar Frequency Interferometer passive ranging. Nonprocessor upgrades include changes to the engine, an improved drive system, and the composite main rotor blade.

The processor technologies are primarily software upgrades that are low risk and easily field-retrofitable into helicopters with minimal cost without having to return to the production-processing facility. According to program officials, there will be costs associated with retrofitting the helicopters but these costs should be minimal given the ability to add software changes in the field and because the helicopter would have to be returned to the production plant to accomplish these upgrades. Also, given the fact that the government will perform the software retrofits on its own as part of the normal software update process, the financial impact will be minimal. Further, based on the current technology readiness levels, program officials believe the technical risk to these technologies is low even though no back-up technologies exist. If, for some reason, the technology is unavailable for insertion at its given time, the program would proceed with the existing technology until the new technology can be incorporated.

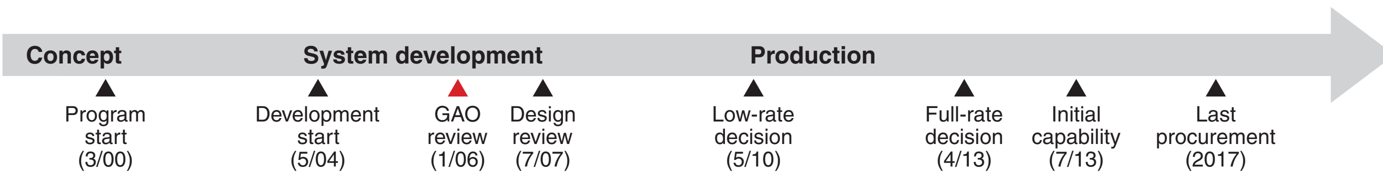
Agency Comments

The Army concurred with our assessment.

Multi-mission Maritime Aircraft (MMA)

The Navy's MMA is part of the Broad Area Maritime Surveillance (BAMS) family of systems, along with the BAMS Unmanned Aerial Vehicle (UAV) and Aerial Common Sensor (ACS). This family of systems is intended to sustain and improve the Navy's maritime warfighting capability. The MMA is the replacement for the P-3C Orion. Its primary roles are persistent antisubmarine warfare; antisurface warfare; and intelligence, surveillance, and reconnaissance capabilities.

Source: The Boeing Company, ©2005 The Boeing Company.



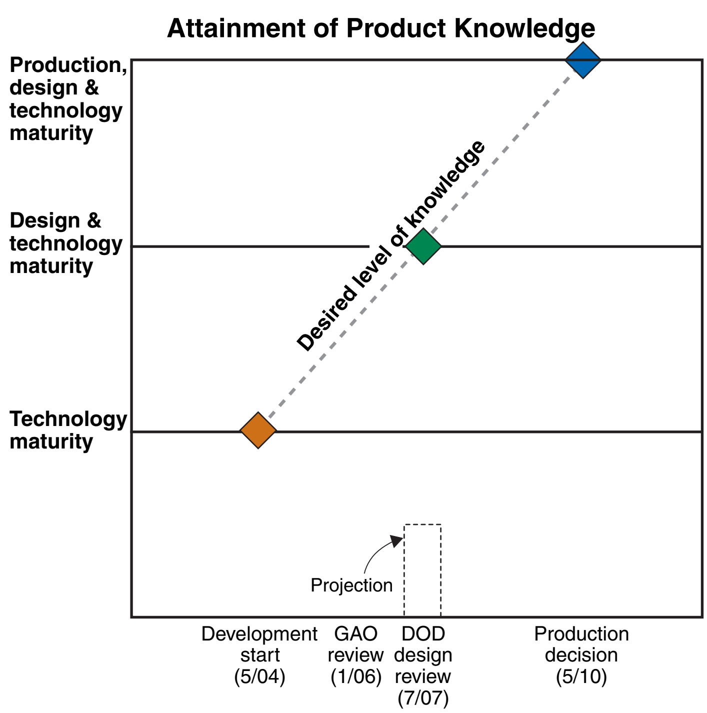
Program Essentials

Prime contractor: Boeing Integrated Defense Systems
Program office: Patuxent River, Md.
Funding needed to complete:
R&D: $5,910.5 million
Procurement: $20,540.6 million
Total funding: $26,572.9 million
Procurement quantity: 108

Program Performance (fiscal year 2006 dollars in millions)

	As of 06/2004	Latest 08/2005	Percent change
Research and development cost	$6,689.1	$6,581.5	-1.6
Procurement cost	$20,752.1	$20,540.6	-1.0
Total program cost	$27,563.5	$27,243.9	-1.2
Program unit cost	$239.682	$236.903	-1.2
Total quantities	115	115	0.0
Acquisition cycle time (months)	160	160	0.0

The MMA program entered development with none of its four critical technologies mature. According to the program office, these technologies will be demonstrated in a relevant environment by design review and tested in an operational environment by the production decision. The program evaluated six other technologies but decided they were not critical because they had already been demonstrated in a relevant or operational environment. The system's technology maturity will be demonstrated at least 3 years later than recommended by best practices standards. However, if those technologies do not mature as expected, the program has identified mature back-up technologies. In addition, during the program's preliminary design review, a recommendation was made to reassess whether all critical technologies in the program have been identified.



MMA Program

Technology Maturity

None of the four critical technologies--integrated rotary sonobuoy launcher, electronic support measures digital receiver, data fusion, and acoustic algorithms--are mature. These technologies have not moved beyond the laboratory environment. For three of the technologies, the components have not been integrated into a prototype system. The program expects the four technologies to be demonstrated in a relevant environment by design review in July 2007 and tested in an operational environment by the production decision in May 2010. The system's technology maturity will be demonstrated at least 3 years later than recommended by best practices standards.

The program office and the contractor developed maturation plans and identified mature backup technologies for each of the critical technologies. According to program officials, the MMA would lose some capabilities but still meet its minimum system requirements if it used these backups. For example, one of the biggest technology challenges for the MMA identified by program officials is the electronic support measures digital receiver. This technology exists as a prototype and has been demonstrated in a high fidelity laboratory environment. The program is leveraging the digital receivers currently in development on the EA-18G program. If the EA-18G digital receiver program is unsuccessful, the program will have to use legacy analog off-the-shelf receivers, which would prevent them from gaining an increased sensitivity for certain signals.

The four technologies we assessed were identified in the MMA's technology readiness assessment. The program evaluated six other technologies but decided they were not critical because they had already been demonstrated in a relevant or operational environment. However, during the program's November 2005 preliminary design review, a recommendation was made to reassess whether all critical technologies in the program have been identified.

Design Stability

We did not assess design stability as the number of releaseable drawings is not yet available.

Other Program Issues

As of August 2005, the MMA program is on budget and on schedule. However, if the MMA fails to develop as expected or experiences schedule slippage, the Navy would have to rely on its aging P-3C Orion fleet, which according to DOD is plagued by serious airframe life issues, poor mission availability rates, high ownership costs, and limited system growth capacity.

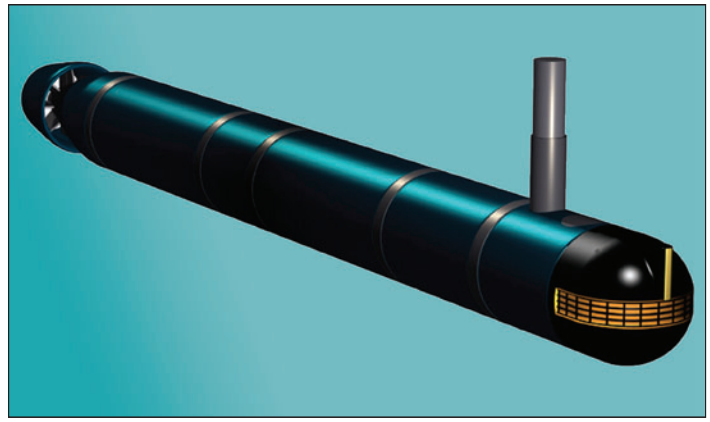
The MMA shares the persistent intelligence, surveillance, and reconnaissance role with the BAMS UAV. The BAMS UAV development start and initial operations capability have been delayed 18 months and three years respectively. If the BAMS UAV does not develop as planned or continues to experience schedule delays, the MMA is its fallback and according to the Navy's most recent analysis, the overall cost of the program would increase due to a need to procure additional MMA aircraft. In addition, a third element planned for the BAMS family of systems is the ACS. The ACS is intended to replace three current systems: the Army's Guardrail Common Sensor, Airborne Reconnaissance Low, and the Navy's EP-3. However, DOD issued a stop-work order to the ACS program prime contractor in September 2005 and terminated the contract in January 2006, because the airframe selected for the ACS could not accommodate the intended ACS mission equipment. Decisions concerning the ACS program that have not yet been made may determine whether the Navy participates in a future ACS program. One of the alternatives previously assessed by the Navy to replace the EP-3 included incorporating the ACS equipment onto the MMA airframe.

Agency Comments

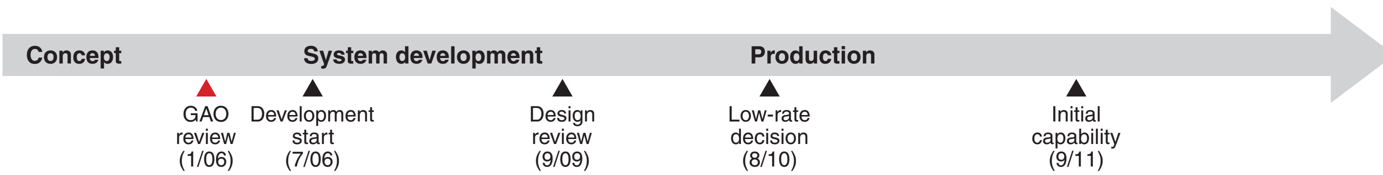
The Navy concurred with GAO's assessment of the MMA program. We incorporated technical comments provided by the Navy as appropriate. The Navy stated that the program continues to manage the four critical technologies. It stated that the maturation of these technologies is on schedule and will be demonstrated in a relevant environment prior to the July 2007 design readiness review. It also stated that the program continues to meet or exceed the cost, schedule, and performance parameters defined in the program's baseline agreement and that the prime contractor also continues to execute the contract within cost and schedule parameters.

21" Mission Reconfigurable Unmanned Undersea Vehicle (MRUUV)

Launched and recovered from submarine torpedo tubes, the Navy's 21" MRUUV will independently perform a range of information gathering activities. It supplants two related programs now limited to prototype development, the long-term mine reconnaissance system and the advanced development unmanned undersea vehicle. Each MRUUV system will include the vehicle, combat and control interfaces, and enabling equipment for either mine countermeasure or ISR missions. This assessment is as of January 2006. The planned July 2006 decision to enter development has since been delayed.



Source: Unmanned Undersea Vehicles Program Office.



Program Essentials

Prime contractor: TBD
Program office: Washington, D.C.
Funding needed to complete:
R&D: TBD
Procurement: TBD
Total funding: TBD
Procurement quantity: 11

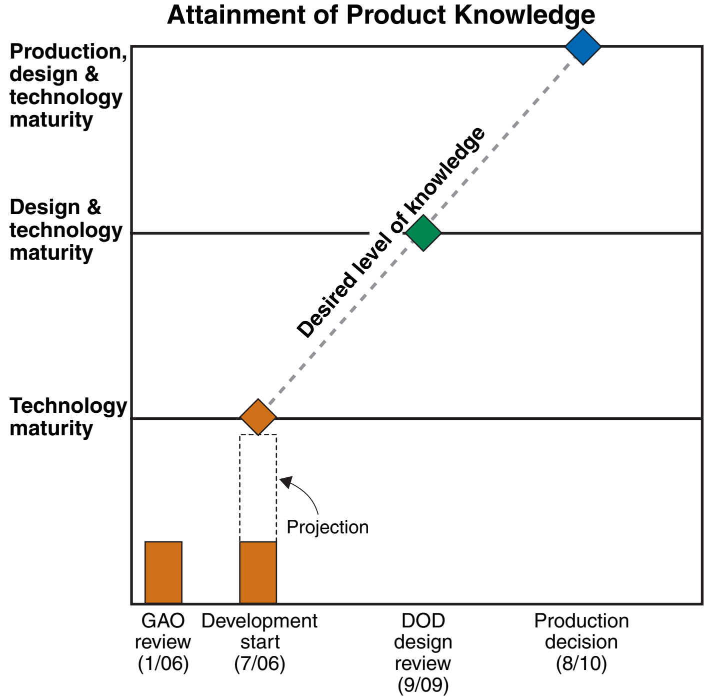
Program Performance (fiscal year 2006 dollars in millions)

	As of NA	Latest 08/2005	Percent change
Research and development cost	NA	NA	NA
Procurement cost	NA	NA	NA
Total program cost	NA	NA	NA
Program unit cost	NA	NA	NA
Total quantities	NA	11	TBD
Acquisition cycle time (months)	NA	62	TBD

Program costs are business sensitive and cannot be published until after MRUUV design contract is awarded.

One of the MRUUV program's six critical technologies is currently mature. While the program expects to have fully matured four of the five remaining critical technologies by the time of development start in July 2006, the final technology--a rechargeable battery for the system--is not expected to reach maturity until 2008. Given the cost growth and schedule slippage experienced on previous unmanned undersea vehicle programs, DOD is treating the program as if it were a larger development effort and providing increased oversight.

Attainment of Product Knowledge



21" MRUUV Program

Technology Maturity

One of the MRUUV's six critical technologies is currently mature and the program expects to have at least four of the remaining five critical technologies fully mature by the start of system development in July 2006. The one exception, a rechargeable battery used for power supply, may require further development to ensure proper integration.

The Littoral Precision Undersea Mapping Array is a critical sonar technology that enables object identification and obstacle avoidance, essentially forming the "eyes" of the vehicle. An advanced development model of the Mapping Array already has been developed, tested, and deployed on a 21" vehicle, thereby successfully demonstrating its mine identification capability. A more advanced, lighter-weight prototype is scheduled to be completed and tested in an operational environment in fiscal year 2006.

The synthetic aperture sonar takes detailed pictures of underwater objects. A surface ship has towed a sonar model in an ocean environment to provide preliminary engineering data. A final prototype, will be completed in fiscal year 2006 and will be tested in open water in early fiscal year 2007.

According to the project manager, the maturity of the software that provides MRUUV's autonomous operational capability has already been demonstrated. This software is currently being used in operational unmanned undersea vehicles and can be applied to the MRUUV to enable it to perform its basic mission requirements. Nevertheless, software development will continue, with incremental improvements added as they are developed. This may include an enhanced ability to make autonomous decisions and functionality that will facilitate a more efficient equipment swap process.

Technology to manage the vehicle launch and recovery process involves acoustic signaling and mechanical activities. A predecessor vehicle on which MRUUV is based has demonstrated homing, docking, and replacement into a model submarine hull. Maturity of this technology could be demonstrated by system development start if at-sea tests with a real submarine are successful.

Intelligence, surveillance, and reconnaissance technology will be used to provide remote monitoring capability, which involves placing the vehicle in a strategic location to listen for specific signals. Such technology, essentially a sensor antenna, already exists and is operational on Navy unmanned aerial vehicle platforms. However, it needs to be miniaturized and adapted for an ocean environment, which should be demonstrated in May 2006 when the technology will be fit onto a small underwater vehicle shell and used in at sea testing.

MRUUV's final critical technology is battery power. Although a stable conventional battery has been developed, the Navy is also pursuing the development of a rechargeable battery. While the rechargeable battery has attained functional capability, it will require further refinement to ensure fit into a small unmanned undersea vehicle. This is expected to occur in 2008.

Other Program Issues

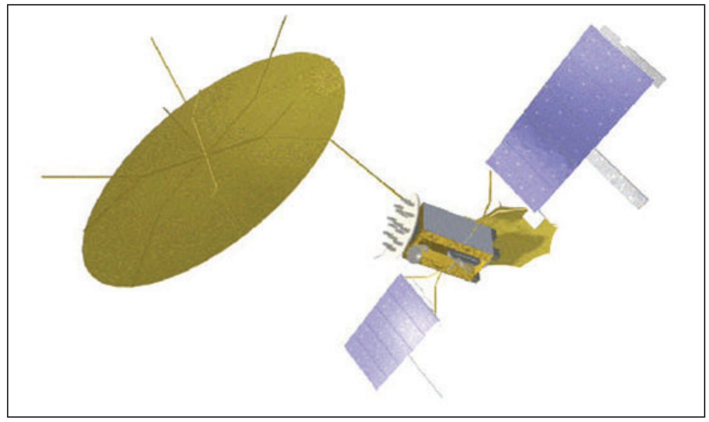
Although total investment in the MRUUV is expected to be less than $365 million in research and development funding, the Office of the Secretary of Defense may designate the program as an Acquisition Category I. Officials at DOD believe that the program requires enhanced oversight and visibility into program activities because of the cost growth and schedule slippage that plagued previous unmanned undersea vehicle programs.

Agency Comments

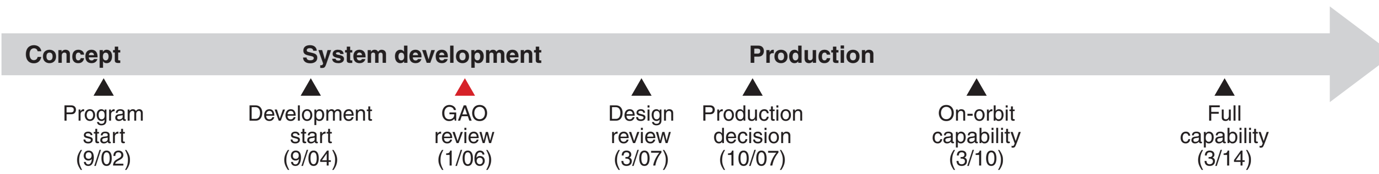
In commenting on a draft of this assessment, the Navy stated that the MRUUV program expects to have demonstrated all major technology risks through other programs or through the science and technology community by the time it reaches system development in July 2006. According to Navy officials, remaining risks will be the responsibility of the prime contractor to address within the systems engineering and design integration process. The Navy also commented that a carefully structured acquisition strategy and risk management program will continue to mitigate risks as the program progresses through its design phase. In subsequent comments, Navy officials noted that, as would be expected of a pre-MDAP program, the MRUUV effort is continuing to evolve and that since GAO conducted its audit work the program has experienced significant changes and is likely to experience additional changes.

Mobile User Objective System (MUOS)

The Navy's MUOS, a satellite communication system, is expected to provide low data rate voice and data communications capable of penetrating most weather, foliage, and manmade structures. It is designed to replace the Ultra High Frequency (UHF) Follow-On satellite system currently in operation and provide support to worldwide, multiservice, mobile, and fixed-site terminal users. MUOS consists of a network of advanced UHF satellites and multiple ground segments. We assessed both the space and ground segments.



Source: Artist rendering of MUOS satellite, Lockheed Martin.



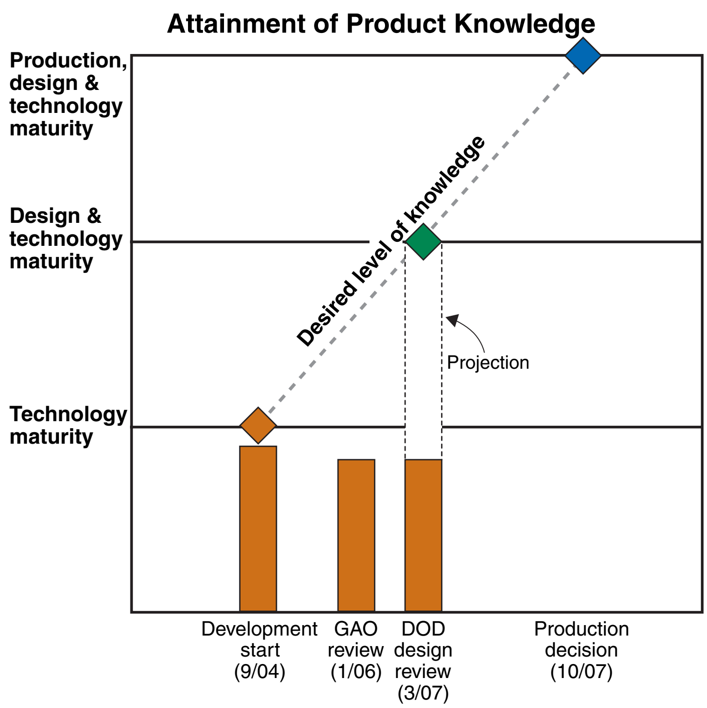
Program Essentials

Prime contractor: Lockheed Martin Space Systems
Program office: San Diego, Calif.
Funding needed to complete:
R&D: $2,547.0 million
Procurement: $2,170.1 million
Total funding: $4,737.1 million
Procurement quantity: 4

Program Performance (fiscal year 2006 dollars in millions)

	As of 09/2004	Latest 08/2005	Percent change
Research and development cost	$3,239.7	$3,169.7	-2.2
Procurement cost	$2,695.6	$2,170.1	-19.5
Total program cost	$5,969.6	$5,373.7	-10.0
Program unit cost	$994.931	$895.611	-10.0
Total quantities	6	6	0.0
Acquisition cycle time (months)	91	91	0.0

In September 2004, the MUOS program was authorized to begin development. The program currently has 9 of 11 critical technologies mature. The remaining technologies are projected to be mature by March 2007, in time for the critical design review. The program intends to order long lead items for the first two satellites before achieving a final design. This early procurement could lead to rework causing cost increases and schedule delays if relevant designs change prior to critical design review. In addition, the MUOS development is schedule-driven, posing several risks to the program.



MUOS Program

Technology Maturity

Eight of nine critical technologies were mature at the development start decision in September 2004. The number of critical technologies has increased by two since our assessment of the program last year due to continuing program analyses resulting in increased knowledge of required technologies. Currently, nine of eleven critical technologies are mature. The remaining technologies, a new cryptographic chip for the ground satellite control segment and a digital to analog converter, are expected to be mature by the time the program reaches its critical design review in March 2007. Mature backup technologies exist in the event that they fail to mature in time. However, use of the backup technologies would increase the vulnerability to attacks on signal transmissions used to ensure the satellites remain properly placed in their orbits and increase risk of program cost and schedule growth.

Design Stability

The MUOS program has begun procuring long lead items for the first two satellites before achieving a final design. According to the program office, $125.5 million (then year dollars) in long lead items are to be ordered before critical design review in March 2007, nearly double the amount estimated last year. Such procurement could lead to rework if relevant designs change prior to the system-level critical design review, causing program cost increases and schedule delays. According to the program office, delaying long lead procurement until after critical design review would cause the program schedule to slip. In addition, the program office noted that the majority of the long lead procurements are planned after respective segment-level critical design reviews (which precede the system-level critical design review) and that most are for standard commercial satellite bus components.

Additionally, the program office has not estimated the total number of design drawings needed to build the satellites, but this number will likely be known next year. The development contract requires the completion of 90 percent of the design drawings as a condition of conducting critical design review.

Other Program Issues

In June 2004, DOD delayed the first MUOS satellite launch by one year to fiscal year 2010 due to a delay in awarding the development contract and to mitigate schedule risk. While the MUOS program has stayed within its cost and schedule estimates, its schedule remains compressed. For example, the importance of the first MUOS launch date has increased due to an unexpected failure of a UHF Follow-On satellite in June 2005. Communication capabilities are now expected to degrade in 2009, one year earlier than previously estimated. Also, operational capability from the first satellite may be used before formal on-orbit operational testing is to take place. Usually, such testing occurs prior to placing a satellite into service. Finally, an independent assessment conducted for the MUOS development start decision states that the program is schedule-driven due to software development.

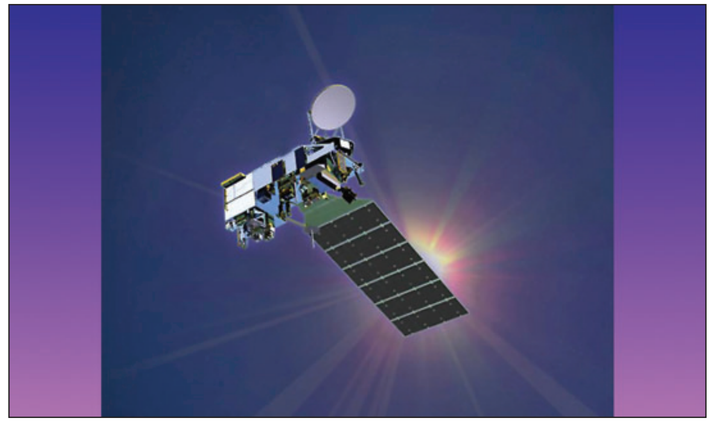
According to the program office, development of MUOS ground software represents one of the highest risks to the program due to the size and complexity of the contractor's design. The program office stated that the ground software is to be developed in three builds comprised of two to four increments each (for a total of eight increments) to mitigate schedule risk. Additionally, the program intends to track and assess software development using numerous metrics we have found to be useful for program success. However, our review of the software development shows cost and schedule growth risks remain due to the concurrent development of the three builds. Specifically, during the approximately 4-year software development time frame, about one-half of this period consists of concurrent development among the software builds. Such concurrency can increase the severity of software problems due to their cascading cost and schedule impacts on other builds.

Agency Comments

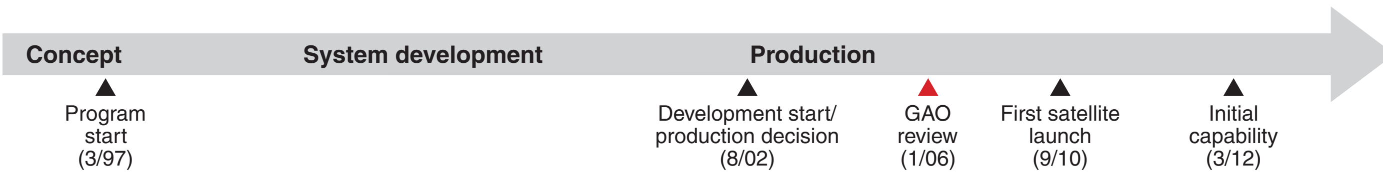
In commenting on a draft of this assessment, the Navy provided technical comments, which were incorporated where appropriate.

National Polar-orbiting Operational Environmental Satellite System (NPOESS)

NPOESS is a triagency National Oceanic and Atmospheric Administration (NOAA), DOD, and National Aeronautics and Space Administration (NASA) satellite program to monitor the weather and environment through the year 2020. Current NOAA and DOD satellites will be merged into a single national system. The program consists of five segments: space; command, control, and communications; interface data processing; launch; and field terminal software. We assessed all segments.



Source: NPOESS Integrated Program Office.



Program Essentials

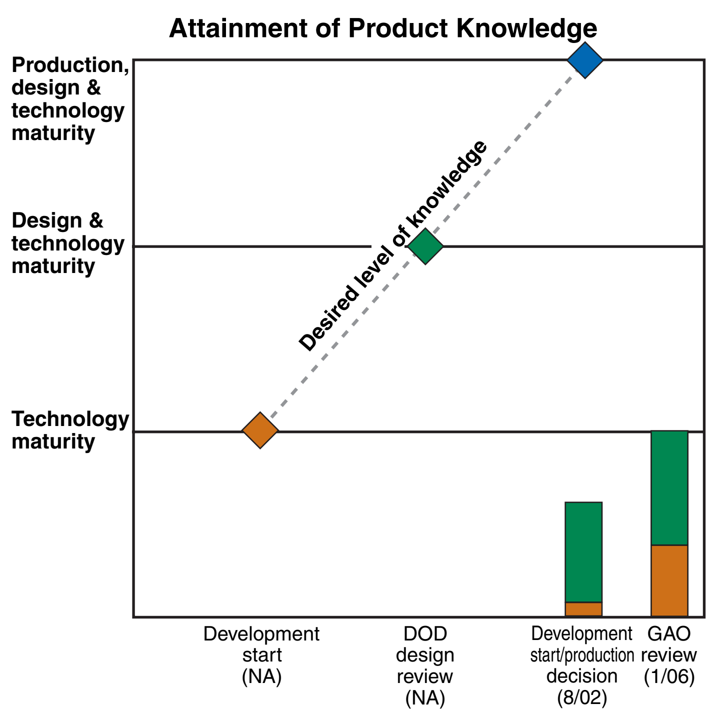
Prime contractor: Northrop Grumman Space Technology
Program office: Silver Spring, Md.
Funding needed to complete:
- R&D: $4,083.7 million
- Procurement: $1,309.6 million
- Total funding: $5,393.3 million
- Procurement quantity: 4

Program Performance (fiscal year 2006 dollars in millions)

	As of 08/2002	Latest 09/2005	Percent change
Research and development cost	$4,717.3	$6,657.8	41.1
Procurement cost	$1,217.9	$1,309.6	7.5
Total program cost	$5,935.2	$7,967.5	34.2
Program unit cost	$989.198	$1,327.909	34.2
Total quantities	6	6	0.0
Acquisition cycle time (months)	172	180	4.7

As a result of technical problems, the program office now estimates the total program cost at about $8.3 billion. As of November 2005, our estimate was about $9.7 billion.

In August 2002, the NPOESS program committed to the development of operationally capable satellites with only 1 of 14 critical technologies mature and about half of its drawings released to manufacturing. All but three of these technologies are expected to be mature by design review in February 2007. The program office is not collecting statistical process control data to assess production maturity because of the small number of units being produced. It considers two of the four critical sensors key program risks because of technical development challenges. In November 2005, our analysis showed the contractor was $253.8 million over budget and may have a potential overrun of about $1.4 billion at completion. The program reported a Nunn-McCurdy (10 U.S.C. 2433) unit cost breach in January 2006, at the 25 percent threshold, due to continuing technical problems.



NPOESS Program

Technology Maturity

Only 1 of the program's 14 critical technologies was mature at the production decision in August 2002. One critical technology was deleted from NPOESS in 2005. The program projects that all but three of the remaining technologies will be mature by the design review in 2007.

The program undertook the NPOESS Preparatory Project, a demonstration satellite, to reduce risk and provide a bridging mission for NASA's Earth Observing System. This satellite is to demonstrate three of the four critical sensors in an operational environment and was scheduled for launch in May 2006. However, the launch of this satellite was delayed 23 months from the contract award date to April 2008. This effort is to provide data processing centers with an early opportunity to work with sensors, ground controls, and data-processing systems and allow for incorporating lessons learned into the NPOESS satellites. Since our assessment last year, the program office reports that three sensors continue to experience cost increases and schedule delays due to technical challenges. Two of these are considered critical sensors.

Design Stability

In August 2002, the program committed to the fabrication and production of two satellites with operational capability before achieving design stability or production maturity. Program officials indicated that about 55 percent of the design drawings have been released to manufacturing, and expect to release about 88 percent by the design review in 2007, which represents a decline of 6 percent from last year's estimate. The design review date and other schedule dates are subject to revision based on the results provided by an independent program assessment, DOD review, and Nunn-McCurdy (10 U.S.C. 2433) certification process.

Production Maturity

We could not assess production maturity because, according to the program office, it does not collect statistical process control data due to the small number of units to be built. However, program officials report the contractors track and use various metrics for subcomponents, such as rework percentages and defect containment, to track production progress.

Other Program Issues

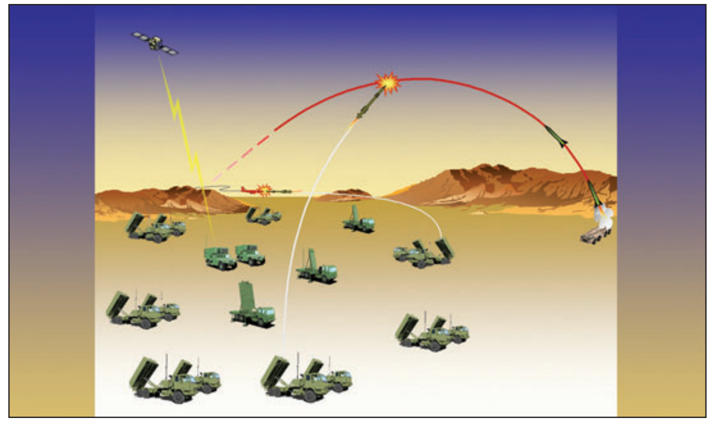
In 2002, DOD extended the launch date of one of its legacy meteorological satellites to 2010, delaying the need for NPOESS and reducing NPOESS funding by about $65 million between fiscal years 2004 and 2007. Funding reductions prompted a restructuring of the NPOESS program. In September 2005, the program office submitted a new total program cost estimate of about $8.3 billion. In November 2005, we estimated total program cost to increase to about $9.7 billion at completion. This represented about a 50 percent increase from the original program cost estimate of $6.5 billion. In January 2006, the program reported a Nunn-McCurdy (10 U.S.C. 2433) unit cost breach, at the 25 percent threshold, due to continuing technical problems. NPOESS officials stated the most recent increase is due to technical issues surrounding the program, including the development of key sensors. In addition, given the challenges currently facing the program, the scheduled first launch date slipped 17 months from the contract award date to September 2010.

Agency Comments

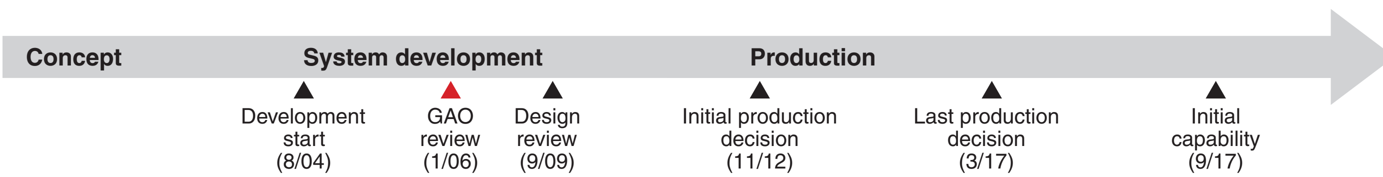
In commenting on a draft of this assessment, the program office stated that every aspect of the program is being evaluated by various internal and external groups and noted that management changes to better align the management structure with the program phase have recently occurred at the program office and at the prime contractor. It stated that management, design, and manufacturing process issues at multiple levels have contributed to the current instrument problems and resulting cost and schedule issues. It further stated that several options are being reviewed for technical viability and cost effectiveness as part of the Nunn-McCurdy (10 U.S.C. 2433) certification process. The program office noted that any changes resulting from this process may produce substantial cost, schedule, and technical performance changes. The program office also noted that part of the schedule slips were due to congressional budget cuts. Technical comments were also provided and incorporated as appropriate.

PATRIOT/MEADS Combined Aggregate Program (CAP) Fire Unit

The Army's Patriot/MEADS Combined Aggregate Program is the process by which the Patriot missile system transitions to the MEADS. The MEADS mission is to provide low-to-medium altitude air and missile defense with the capability to counter, defeat, or destroy tactical ballistic missiles, cruise missiles, and other air-breathing threats. MEADS is a codevelopment program among the United States, Germany, and Italy. We assessed the MEADS fire unit portion of the program.



Source: MEADS NPO, Lower Tier Project Office.



Program Essentials

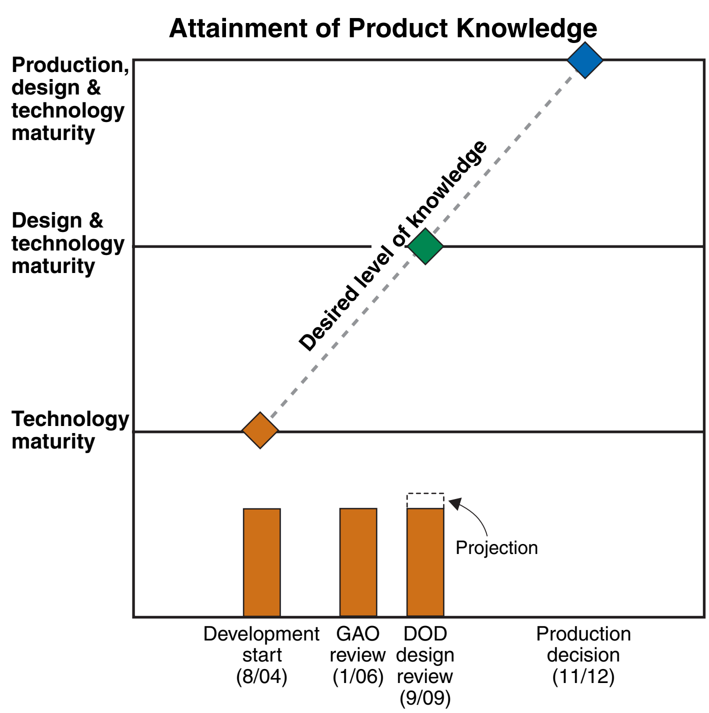
Prime contractor: MEADS International
Program office: Huntsville, Ala.
Funding needed to complete:
- R&D: $4,306.8 million
- Procurement: $12,149.2 million
- Total funding: $16,456.0 million
- Procurement quantity: 48

Program Performance (fiscal year 2006 dollars in millions)

	As of 08/2004	Latest 08/2005	Percent change
Research and development cost	$4,714.3	$4,613.0	-2.1
Procurement cost	$12,483.5	$12,149.2	-2.7
Total program cost	$17,197.8	$16,762.2	-2.5
Program unit cost	$358.287	$349.212	-2.5
Total quantities	48	48	0.0
Acquisition cycle time (months)	158	157	-0.6

The program office expects the first complete MEADS fire unit to be available in fiscal year 2015.

The MEADS fire unit began development in 2004 with two mature critical technologies, three critical technologies nearing maturity, and one immature critical technology. The technologies remain at these levels. Program plans call for a system design review in 2009, but program estimates project that only one of the six fire unit technologies will be more mature at that time than at development start. The program office anticipates that all critical technologies will be fully mature by the start of production in the first quarter of fiscal year 2013.



PATRIOT/MEADS CAP Fire Unit Program

Technology Maturity

Only two of the six critical technologies--launcher electronics and Patriot Advanced Capability (PAC)-3 missile integration--are mature. Three other critical technologies--low noise exciter that manages the radars' frequencies, cooling system for the radars, and slip ring that carries power and coolants to the radars--are nearing maturity. The remaining critical technology--the transmit/receive module that transmits/receives signals for the fire control radar--is immature.

The program office projects that the transmit/receive module will increase in maturity by the time of the system design review planned for 2009. The program office expects that the five other critical technologies will be at the same maturity levels as they were at the start of development. The office expects all critical technologies to be fully mature by the start of production in late 2012. There are no backup technologies for any of the MEADS critical technologies.

Design Stability

We could not assess the design stability of MEADS because the number of releasable drawings and total drawings expected were not available. The program office expects to know the total number of releasable drawings at the design review in 2009.

Other Program Issues

MEADS is being developed to employ the current PAC-3 missile and the future PAC-3 missile segment enhancement variant. The missile segment enhancement is a U.S.-funded effort to improve on the current PAC-3 missile capability. Program estimates indicate that the Army plans to develop and procure missiles at a cost of approximately $6.1 billion. We did not assess the missile and the missile segment enhancement, and the associated costs are not included in our funding information.

The MEADS program has adopted an incremental acquisition approach wherein MEADS major items are incrementally inserted into the current Patriot force. There are three increments, with the first beginning in 2008, another in 2010, and the final in 2013. The program office plans for each increment to introduce new or upgraded capability into the program. The Army expects MEADS to achieve initial operating capability in 2017 with four units.

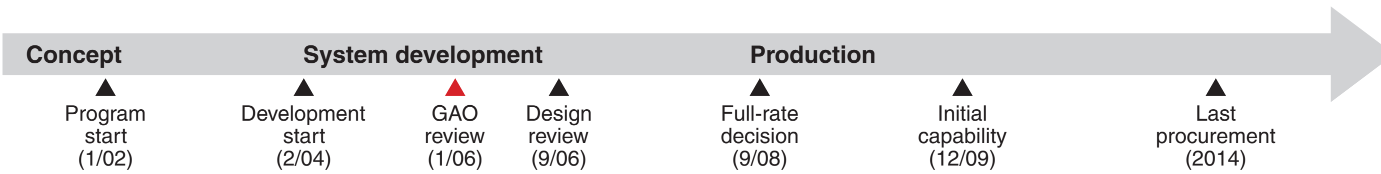
Agency Comments

The Army generally concurred with this assessment. It indicated that we addressed critical technologies that were already areas of intense management focus. The Army also noted that it still expects all technologies to be fully mature by production and further stated that there are risk mitigation plans for the maturing technologies and alternate back-up technologies identified for the transmit/receive module. Additionally, the Army noted that, at the design review in 2009, the design work in the critical technologies will be at the maturity level required to fabricate the system prototype necessary to demonstrate required system capabilities.

MQ-9 Predator B

The Air Force's MQ-9 Predator B is a multirole, medium-to-high altitude endurance unmanned aerial vehicle system capable of flying at higher speeds and higher altitudes than its predecessor, the MQ-1 Predator A. The Predator B is designed to provide a ground attack capability to find and track small ground mobile or fixed targets. Each Predator B system will consist of four aircraft, a ground control station, and a satellite communication suite. We assessed the first increment of the air vehicle.

Source: General Atomics-Aeronautical Systems, Incorporated.



Program Essentials

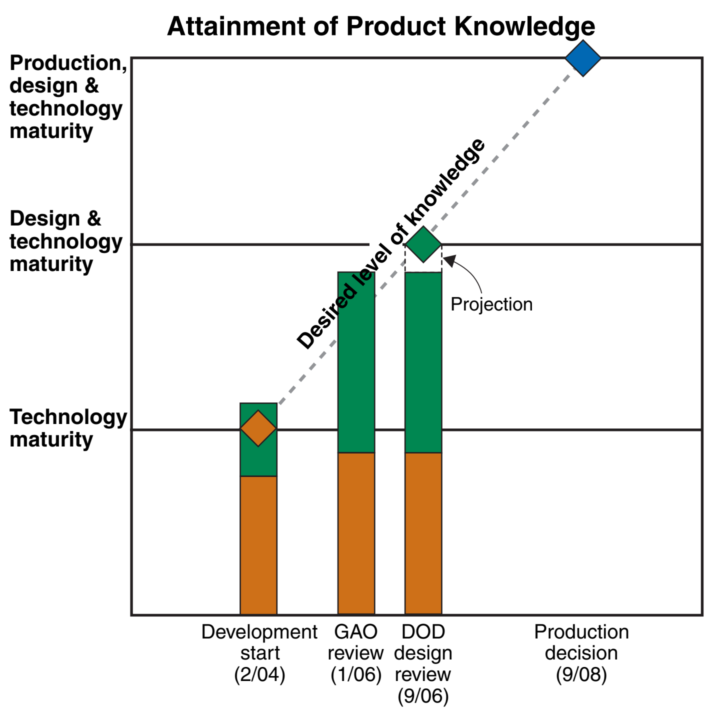
Prime contractor: General Atomics Aeronautical Systems Incorporated
Program office: Dayton, Ohio
Funding FY06-FY11:
- R&D: $127.7 million
- Procurement: $635.5 million
- Total funding: $763.1 million
- Procurement quantity: 32

Program Performance (fiscal year 2006 dollars in millions)

	As of 08/2004	Latest 08/2005	Percent change
Research and development cost	$179.6	$183.6	2.2
Procurement cost	$523.5	$595.2	13.7
Total program cost	$703.2	$778.8	10.8
Program unit cost	TBD	TBD	TBD
Total quantities	63	63	0.0
Acquisition cycle time (months)	70	70	0.0

Cost data are for all known costs from the program's inception through fiscal year 2009. Total estimated program cost is $1,209.4 million.

The Predator B entered system development in February 2004 with three of its four critical technologies mature. The Air Force expects the fourth technology to be ready in May 2006. However, no suitable back-up technology is available. If this technology fails to mature as expected, the Predator B will not be able to effectively perform its primary mission--to destroy enemy targets. In 2004, the program changed to an incremental acquisition strategy. The Air Force appears to have made significant progress in completing design drawings for the first increment and projects that it will have achieved design stability by the 2006 critical design review. The program has already begun production of the Predator B aircraft, but operational testing is not scheduled to be complete until 2008. At that point, about one-third of the quantity will be on contract or delivered.



Predator B Program

Technology Maturity

Three of the Predator B's four critical technologies--the synthetic aperture radar, the multispectral targeting system, and the air vehicle--are fully mature. The prototype of the avionics subsystem technology, designed to integrate and store data necessary to launch munitions, will begin ground testing in February 2006. The Air Force expects that the technology will be integrated and mature in May 2006. This represents about a 10 month slip from last year's estimate. No suitable back-up technology exists. If this critical technology fails to mature, it will prevent the Predator B from effectively performing its primary mission, to destroy enemy targets. Subsequent increments may require other new technologies.

Design Stability

After its Milestone B approval in February 2004, the program office was directed to revise its acquisition strategy to develop Predator B in three increments. The Air Force appears to have made significant progress in completing design drawings for the first increment of Predator B. At the time of our assessment last year, the program indicated that just over 35 percent of the drawings for the first increment had been completed. It now reports that over 85 percent of the drawings are complete. The program office continues to expect that 94 percent of the drawings for the first increment will be completed by the time of the critical design review in September 2006. Program officials acknowledge that additional drawings will be needed for subsequent increments. Design changes and modification of drawings are likely to occur late in development, increasing the need to retrofit already acquired systems.

Production Maturity

Program officials said the contractor does not plan to use statistical process controls to ensure product quality. Instead, it plans to use other quality control measures such as scrap, rework, and repair to track product quality. Also, initial operational testing, which is to demonstrate that a product is ready for production, is not scheduled to be complete until mid-2008. By that point, about one third of the aircraft will either be in production or already delivered.

Other Program Issues

In 2004, the Predator program office was directed to adopt an incremental acquisition strategy and field an interim combat capability by fiscal year 2006. By adopting an incremental acquisition strategy, the program office is using the preferred approach to weapon acquisitions. To reduce the risks of concurrently developing and producing Predator Bs, the program office lowered annual buy quantities and extended production 5 years through 2014. Nevertheless, the program schedule still contains a high degree of concurrency. Before the conclusion of initial operational testing, the Air Force will have already contracted for about one third of the total aircraft production quantity. The Air Force currently projects that half of these aircraft will need to be retrofitted to bring them up to the baseline capability. Additional changes stemming from the test program would further perturb the aircraft's cost, schedule, and manufacturing plan.

The Air Force is still evaluating a variety of lightweight munitions for use on the Predator B. The Air Force is also weighing the possibility of adding new system capabilities such as launching very small or micro unmanned aerial vehicles from the Predator B.

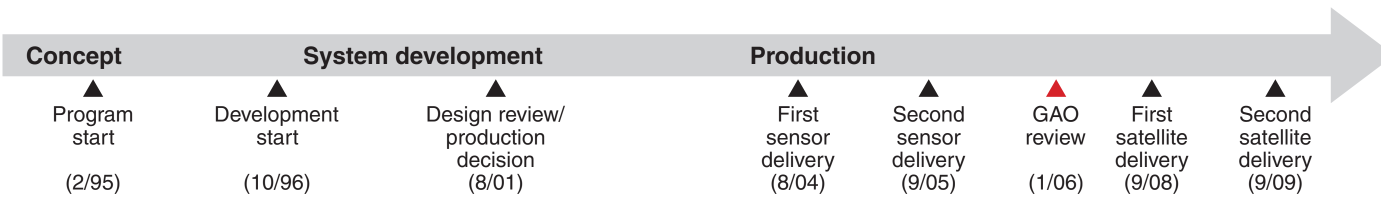
Agency Comments

In commenting on a draft of this assessment, the Air Force stated that the stores management system is making good progress and its completion is considered a low risk activity. The hardware has been installed on a test aircraft and will begin ground testing in February 2006. The Air Force also noted that Congress has directed an increase to the yearly production buys in fiscal years 2004 and 2005. Program planning is in place to upgrade these aircraft to support initial operational testing in 2008. The Air Force stated that the ongoing developmental and operational testing effort and the operational assessment to be conducted in 2006 will provide valuable feed back to the acquisition and operational commands.

Space Based Infrared System (SBIRS) High

The Air Force's SBIRS High program is a satellite system intended to meet requirements in the missile warning, missile defense, technical intelligence, and battlespace characterization missions. A replacement for the Defense Support Program, SBIRS High consisted of four satellites (plus a spare) in geosynchronous earth orbit (GEO), two sensors on host satellites in highly elliptical orbit (HEO), and fixed and mobile ground stations. In 2005, the number of GEO satellites was reduced to three. We assessed the sensors and satellites only.

Source: Lockheed Martin Space Systems Company.



Program Essentials

Prime contractor: Lockheed Martin Space Systems Company
Program office: El Segundo, Calif.
Funding needed to complete:
R&D: $3,498.9
Procurement: $1,629.6
Total funding: $5,128.5
Procurement quantity: 1

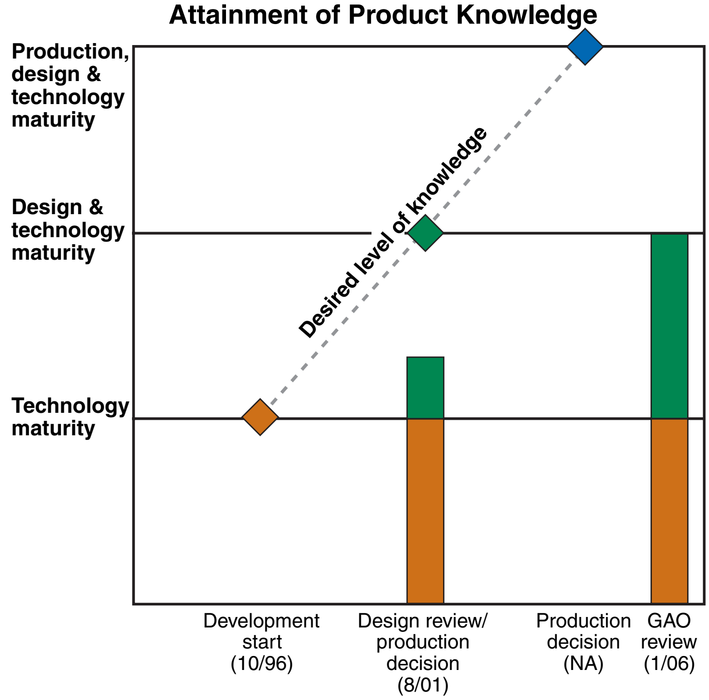
Program Performance (fiscal year 2006 dollars in millions)

	As of 10/1996	Latest 09/2005	Percent change
Research and development cost	$3,888.5	$8,275.8	112.8
Procurement cost	$0.0	$1,723.7	NA
Total program cost	$4,079.4	$10,168.1	149.3
Program unit cost	$815.890	$3,389.367	315.4
Total quantities	5	3	-40.0
Acquisition cycle time (months)	TBD	TBD	TBD

Acquisition cycle time is currently unknown as the Air Force Space Command has not defined the initial operational capability.

The SBIRS High program's critical technologies and design are now mature. Production maturity could not be determined because the contractor does not collect production statistical process control data. In August 2004 the contractor delivered the first payload (HEO 1 sensor) after a delay of 18 months; the second was delivered in September 2005 after a delay of 21 months. Since we last reported, total costs have increased by more than $1 billion. The cost growth resulted in two additional Nunn-McCurdy (10 U.S.C. 2433) unit cost breaches and a decision not to buy two satellites. Although program officials have acknowledged that the GEO satellites are orders-of-magnitude more complex than the HEO sensors, they now believe a more realistic program schedule has been developed. The first GEO satellite delivery has been delayed an additional 5 months to late 2008.

Attainment of Product Knowledge



SBIRS High Program

Technology Maturity

The SBIRS High program's three critical technologies--the infrared sensor, thermal management, and on-board processor--are mature. However, program officials stated that flawed initial systems engineering created first-time integration and test risk associated with the GEO staring sensor. According to program officials, early test results of the scanning and staring sensors are positive. The staring sensor is to have the ability to stare at one earth location and then rapidly change its focus area, representing a significant leap in capability over the current system.

Design Stability and Production Maturity

In portraying the program's events in this assessment, we considered the production decision to have occurred at the time of design review because this is when the program office began ordering long lead parts for the fabrication of satellites. Although the program's design is now considered stable since almost all drawings have been released, design-related problems are now the issue. Design problems led to delayed delivery of both HEO sensors, which were accepted for operations without meeting all program specifications. Given the added complexity of the GEO satellites over the HEO sensors, the probability is high that major design flaws will be discovered on the GEO satellites as well.

We could not assess the production maturity of SBIRS High because the contractor does not collect production statistical process control data. However, the program office tracks and assesses production maturity through detailed monthly manufacturing and test data and monthly updates on flight hardware qualifications. The program office, in late 2005, implemented initiatives for its flight software development processes and placed full-time program office personnel at the contractor's facility. According to program officials, about 95 percent of flight hardware for the first GEO satellite and 85 percent for the second has been delivered.

Other Program Issues

Integration and testing of the first GEO payload and spacecraft has begun. It was during this process that the design errors in the HEO sensors were discovered. Given the high probability that major design flaws will emerge on these satellites as well, costly redesigns that could further delay delivery are likely. However, according to program officials, additional engineering tests have been instituted to address design issues and reduce the likelihood of significant schedule impacts. To accommodate these tests, each GEO satellite's delivery was delayed by an additional five months, bringing the delay to 19 months for each satellite.

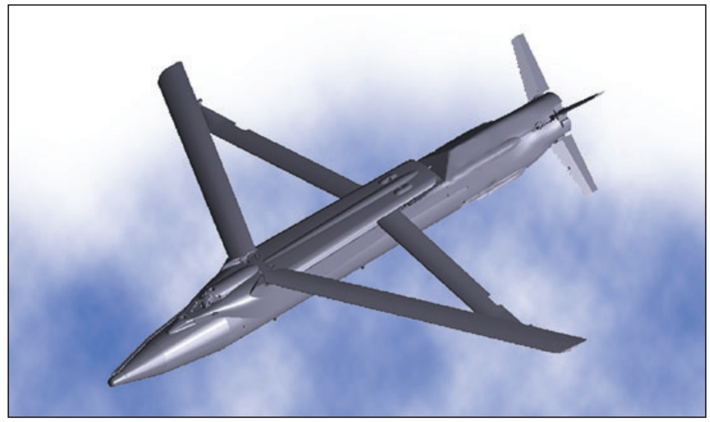
In July 2005, the program reported its third and fourth Nunn-McCurdy unit cost breaches (10 U.S.C. 2433). As part of the mandatory program certification process triggered by one of the cost breaches, the program was restructured in late 2005. The program now includes procurement of only one GEO satellite--reduced from three--and the procurement contract is contingent upon the performance of the first developmental GEO satellite. Although the program has reduced the total number of satellites it will procure, total program funding continues to increase, and revised estimates indicate the average procurement cost per unit is now 224 percent above the 2002 approved program baseline. The Air Force was recently directed to begin efforts to develop a viable competing capability, in parallel with the SBIRS program, and to submit a plan for this new program by April 2006.

Agency Comments

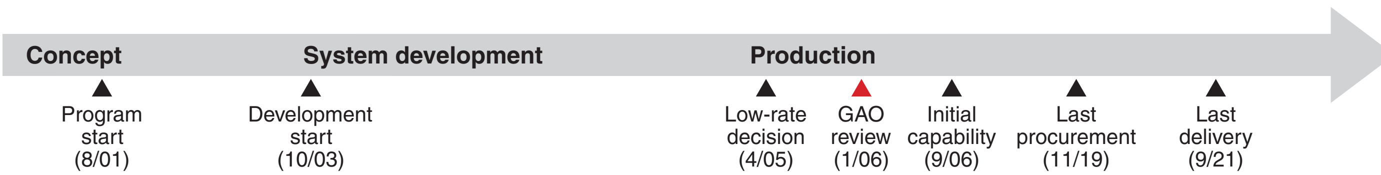
In commenting on a draft of this assessment, the Air Force acknowledged that the cost of the program was significantly underestimated at inception and the program suffered from a lack of military specifications with proper quality controls and that past restructures and replans did not fully recognize the extent of rework necessary to ensure mission success. It noted that the recent comprehensive review of the program resulted in a more realistic assessment of integration and testing timelines and a revised funding profile that accounts for the potential rework costs and schedule delays. In addition, the program has developed one integrated schedule for the remaining program and created a government cost estimating capability. The Air Force noted that technical issues will be uncovered, but early problem identification and prompt resolution will minimize the impacts to the integrated program activity. Technical comments were provided and incorporated where appropriate.

Small Diameter Bomb (SDB)

The Air Force's SDB is a small autonomous, conventional, air-to-ground, precision bomb able to strike fixed and stationary targets. The weapon will be installed on the F-15E aircraft and is designed to work with other aircraft, such as the F-22A. The Air Force is in the process of implementing a competitive acquisition strategy for a second increment of the program, which includes a precision strike against moving targets in adverse weather capability. This analysis addresses only the first increment of the program.



Source: The Boeing Company, St. Louis, Missouri.



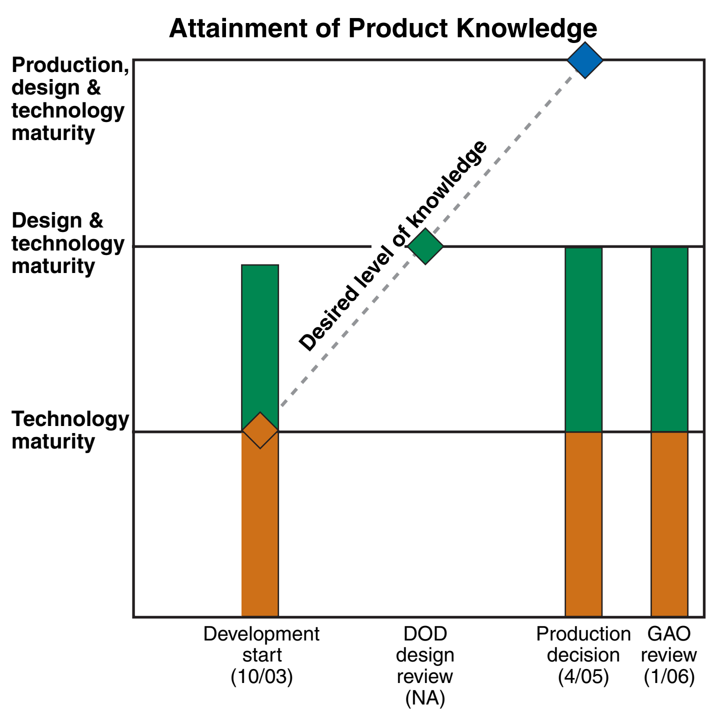
Program Essentials

Prime contractor: Boeing
Program office: Eglin AFB, Fla.
Funding needed to complete:
- R&D: $51.2 million
- Procurement: $1,215.6 million
- Total funding: $1,266.9 million
- Procurement quantity: 23,842

Program Performance (fiscal year 2006 dollars in millions)

	As of 10/2003	Latest 12/2004	Percent change
Research and development cost	$395.8	$384.2	-2.9
Procurement cost	$1,252.9	$1,244.8	-0.6
Total program cost	$1,648.7	$1,629.0	-1.2
Program unit cost	$.068	$.068	-1.2
Total quantities	24,070	24,070	0.0
Acquisition cycle time (months)	62	61	-1.6

The six critical technologies for the SDB are mature, and the design is stable. The program office held the design review prior to starting system development and, although data were not collected, the program maintains that the contractor has released 100 percent of the production drawings. In 2004, the program began a test program, which combines developmental, live fire, and operational testing in an effort to decrease time spent in system development. Of 37 developmental tests conducted, 35 were considered successful. Causes of failure for the other two have been identified and corrected. Some operational tests remain to be completed. SDB was approved for low rate production in April 2005. We could not assess production maturity as statistical process control data were not available.



SDB Program

Technology Maturity

The program office assessed all six critical technologies for the SDB as mature. The technologies are the airframe, the Anti-Jam Global Positioning System, the fuze, the Inertial Navigation System, the carriage, and warhead. Program officials stated that all technologies have been tested in realistic environments and have achieved their final form, fit, and function.

Design Stability

The design review was held prior to the start of system development and, although data were not collected, the program office maintains that Boeing has now completed 100 percent of the production drawings. According to the program office, although the contractor has ultimate responsibility for the weapon system and has given the government a 20-year "bumper to bumper" warranty, the program office has insight into the contractor's configuration control board process and all changes are coordinated with the government.

The SDB program began a program of developmental, live-fire, and operational testing in 2004. This combined testing approach is designed to eliminate or reduce redundant testing. As of the date of this review, all developmental tests were complete. Of the 37 developmental tests conducted, two were classified as failures. Program officials told us that the causes of the two failures have been corrected and verified through additional flight tests. However, due to the concurrency of the test program, SDB continues to face an aggressive schedule in the coming months. Operational testing will be conducted throughout fiscal year 2006, to be followed by a full rate production decision at the end of fiscal year 2006.

Production Maturity

We could not assess production maturity because statistical process control data were not available. In developing the SDB, Boeing used many key components that are common with the Joint Direct Attack Munition (JDAM). The SDB production line will be colocated in the same facility used to produce the JDAM. According to program officials, the production line layout is very similar to the processes currently used for the JDAM. As of the date of this review, no critical manufacturing processes that impact the critical system characteristics had been identified. SDB was approved for low-rate initial production in April 2005 and will begin full-rate production in 2006.

Other Program Issues

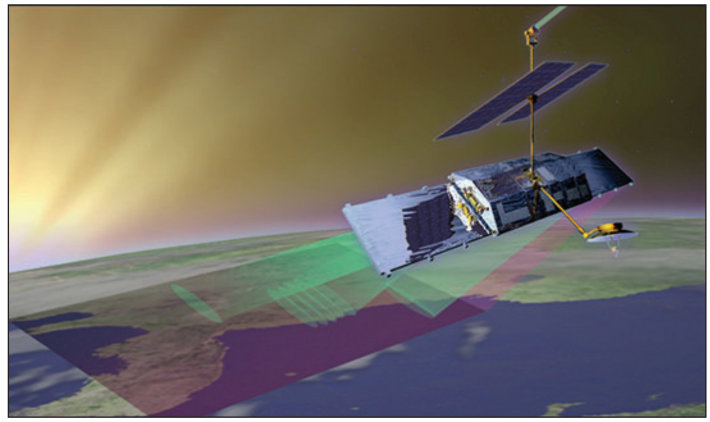
The Air Force's 2006 budget includes $47 million to begin development of the second increment of the SDB program. At the time the fiscal year 2006 budget was prepared, the Air Force planned to have Boeing, the prime contractor for the first increment, add the second increment requirements to the first increment contract. However, in late 2004, Lockheed Martin filed a bid protest of the contract award to Boeing, after a former senior Air Force procurement official acknowledged bias in favor of Boeing. In February 2005, GAO sustained the protest. Responding to the GAO's decision and recommendation, the Air Force agreed to recompete the contract for the second increment. The Air Force is in the process of implementing a competitive acquisition strategy for a second increment.

Agency Comments

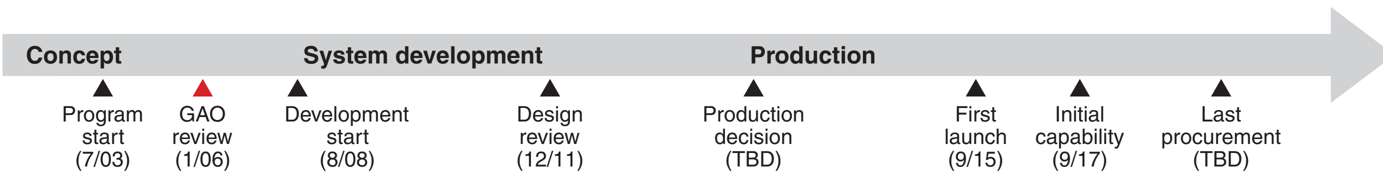
In commenting on a draft of this assessment, the Air Force concurred with the information presented and provided technical comments, which were incorporated as appropriate.

Space Radar (SR)

SR is an Air Force-led, joint DOD and intelligence community program to develop a satellite to find, identify, track, and monitor moving or stationary targets under all-weather conditions and on a near-continual basis across large swaths of the earth's surface. As envisioned, SR would generate volumes of radar imagery data for transmission to ground-, air-, ship-, and space-based systems. We assessed the space segment.



Source: Space Radar Integrated Program Office.



Program Essentials

Prime contractor: TBD
Program office: Colorado Springs, Colo.
Program Office: Eglin AFB, Fla.
Funding needed to complete:
- R&D: $9,726.9 million
- Procurement: $9,767.6 million
- Total funding: $22,970.7 million
- Procurement quantity: 22

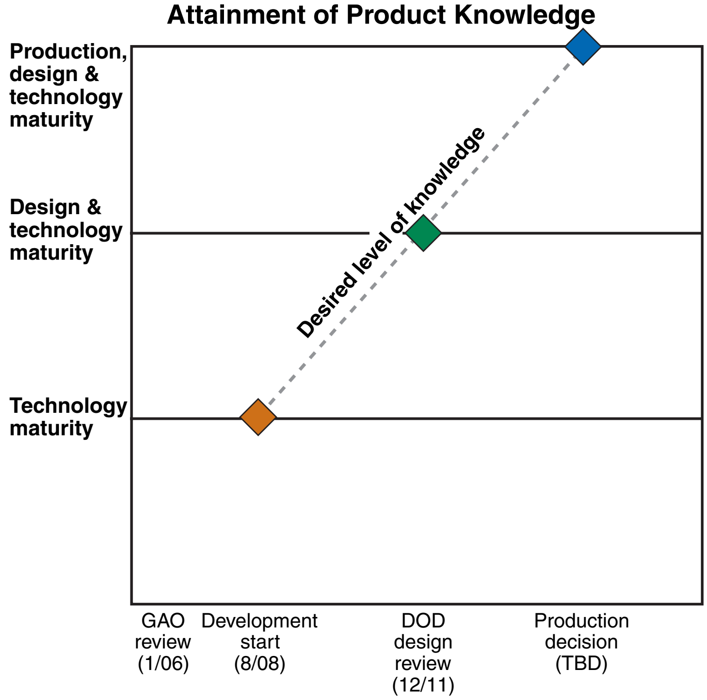
Program Performance (fiscal year 2006 dollars in millions)

	As of NA	Latest 01/2006	Percent change
Research and development cost	NA	$10,094.2	NA
Procurement cost	NA	$9,767.6	NA
Total program cost	NA	$23,338.0	NA
Program unit cost	NA	$1,060.819	NA
Total quantities	NA	22	NA
Acquisition cycle time (months)	NA	170	NA

Cost and quantities could change because the Air Force is restructuring the SR program.

Five critical technologies will support the SR program, and they are still being matured. The program office is focusing its efforts on technology risk reduction and concept definition activities. At this point, the program is expected to enter system development before any of the technologies are mature. The Air Force is restructuring the program to address concerns about the affordability of SR, which includes schedule and cost evaluations and several changes to the acquisition strategy. In 2007, the program plans to decide whether to develop on-orbit demonstration satellites to validate technology maturity and costs. Launch of the first fully operational SR satellite is scheduled for fiscal year 2015. Design and production maturity could not be assessed because SR is not yet a formal acquisition and has not begun product development.

Attainment of Product Knowledge



SR Program

Technology Maturity

The program office assessed the electronically steered array, on-board processing, signal-processing algorithms for moving target indication, information management system, and moving-target indication exploitation hardware and software as the critical technologies needing further development.

The program office is focusing its efforts on technology risk reduction and concept definition activities. For example, subcomponents for the electronically steered array are being integrated with laboratory components to demonstrate proper functioning. In addition, on-board processing capabilities are being demonstrated and conceptual designs for storing and processing data have been developed. The program is also working to further mature the remaining critical technologies. However, the program expects to start the product development phase before these technologies mature.

Other Program Issues

As a result of congressional concerns about the affordability of SR, DOD and other SR users have now agreed on a path to develop a single space radar system to meet national needs. The Air Force is restructuring the program to reflect this agreement and schedule and associated costs are being evaluated. The new path includes several changes to the SR acquisition. First, in early 2005, a new Space Radar Integrated Program Office was established in Chantilly, Virginia, to work with the intelligence community, DOD and other users, senior Air Force leadership, and the Congress. Second, the new SR senior leadership established a framework with overarching guidance for maturing the critical technologies. Third, a team of program office personnel and mission partners established a new plan to drive fiscal year 2006 risk reduction activities and revised cost estimates. Finally, the SR acquisition strategy now calls for the development of a smaller constellation of high performance, more affordable satellites and a potential on-orbit demonstration to validate technology maturity and costs. A final decision on an on-orbit demonstration is not expected until fiscal year 2007.

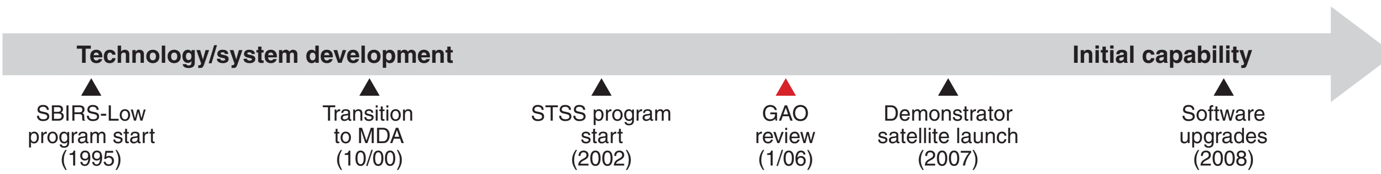
Agency Comments

In commenting on a draft of this assessment, the Air Force stated that in response to congressional concerns and as a result of the recent restructure, the program has implemented a disciplined program framework approach to mature technology and reduce risk and is working more closely with all stakeholders. The Air Force also said that this program framework consolidates and provides coherent big picture direction to multiple technology-development testing and experimentation activities—such as ground, existing space, and air components—with a focus on proving technologies early in the concept development phase of the program to reduce technical and schedule risk in the future. Moreover, according to Air Force officials, a robust requirements definition process has been implemented to provide early stakeholder input and acceptance to stabilize requirements, further reducing future risk.

Space Tracking and Surveillance System (STSS)

MDA's STSS element is being developed in incremental, capability-based blocks designed to track enemy missiles throughout their flight. The initial increment is composed of two demonstration satellites built under the Space Based Infrared System Low program. MDA plans to launch these satellites in 2007 to assess how well they work within the context of the missile defense system. MDA is also studying improvements to the STSS program, and it will be building next generation satellites. We assessed the two demonstration satellites.

Source: STSS Program Brief.



Program Essentials

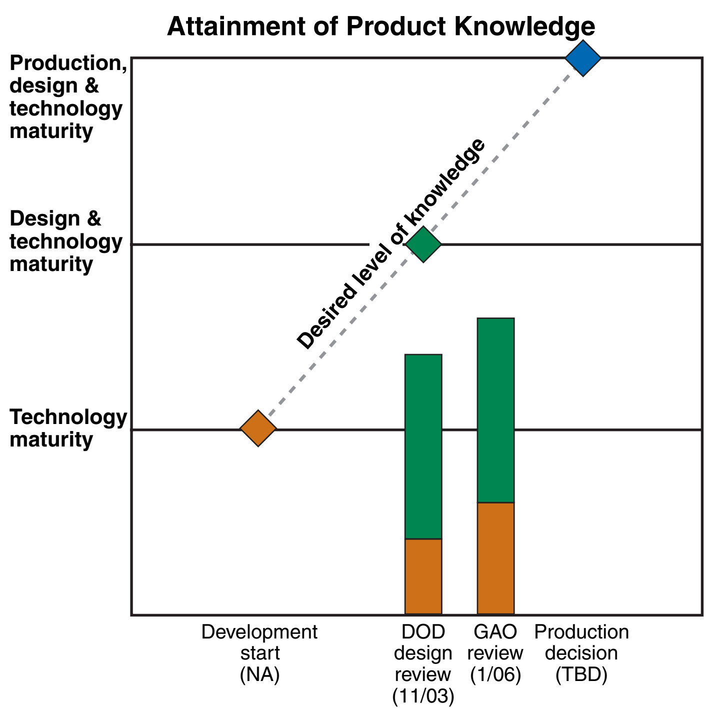
Prime contractor: Northrop Grumman Space Technology
Program office: El Segundo, Calif.
Funding, FY06-FY11:
- R&D: $3,146.4 million
- Procurement: $0.0 million
- Total funding: $3,146.4 million
- Procurement quantity: 0

Program Performance (fiscal year 2006 dollars in millions)

	As of 02/2004	Latest 02/2005	Percent change
Research and development cost	$3,386.8	$4,582.7	35.3
Procurement cost	$0.0	$0.0	0.0
Total program cost	$3,386.8	$4,582.7	35.3
Program unit cost	TBD	TBD	TBD
Total quantities	2	2	0.0
Acquisition cycle time (months)	TBD	TBD	TBD

Columns include all known costs and quantities from the program's inception through fiscal year 2009. Total known program cost through fiscal year 2011 is $5,996.34 million.

Three of the STSS program's five critical technologies are mature, and the remaining two technologies are expected to reach maturity in early 2006. The STSS design appears otherwise stable, with all drawings released to manufacturing. The program office has identified certain risk areas, such as infrared payload completion, payload data processor software completion, and system integration and functionality. Additionally, quality and workmanship problems with the payload have continued and have resulted in cost and schedule overruns with the payload contract. However, the program office still expects early delivery and launch of the satellites. The planned budget for STSS through fiscal year 2009 grew by more than $1.1 billion, mainly in fiscal years 2008 and 2009, due to the addition of funds for designing and developing the program's operational constellation.



STSS Program

Technology Maturity

Three of the five critical technologies--satellite communication cross-links, on-board processor, and acquisition sensor--are mature. This is one less than reported last year as MDA corrected its assessment of one of the technologies. The remaining two technologies--the track sensor and the single-stage cryocooler--will be mature upon completion of the thermal vacuum testing on the first satellite's payload, which is expected to occur in early 2006.

Design Stability

The STSS program's design is stable, with all drawings released to manufacturing. When the STSS program started in 2002, design drawings and the satellite components for the partially built satellites from the Space Based Infrared System Low effort were released to manufacturing. By the time STSS went through its design review in November 2003, the program office had released all subsequent design drawings. However, until the maturity of the remaining two STSS technologies has been demonstrated, the potential for design changes remains.

Other Program Issues

The STSS program is in the process of completing the assembly, integration, and testing of the satellite components and software development. Until this work is complete, certain risk areas will remain. These include infrared payload completion, payload data processor software completion, and system integration and functionality testing. Other risk areas that the program office had identified previously--such as the hardware and software status, ground software development completion, and parts obsolescence--have been resolved.

The quality and workmanship problems with the payload subcontractor persist. These problems have continued for the last 2 years and have contributed to a schedule delay in delivering the payload and a likely cost overrun of between $20 million and $30 million on the payload subcontract. Integration issues have also been discovered as the subcontractor continues to integrate and test the payload at successively higher levels of integration. The cause of most of these problems is due to the difference in configuration between the pathfinder hardware that served as the test bed for the payload software and the actual flight hardware. In addition, the actual payload thermal vacuum test is taking about 30 to 45 days longer than expected to resolve hardware issues that have emerged as a result of the payload being tested in a vacuum and at cold temperatures--a relevant environment--for the first time. In response to these issues, quality control efforts at the subcontractor's site have undergone significant restructuring. In addition, the prime constractor stepped up its inspection and supervision of all processes at the subcontractor's site and has provided mentoring.

According to the program office, many of the quality-related variances could have been avoided if better quality processes had been in place at the payload subcontractor. The program office expects that the quality improvements that the payload subcontractor has implemented will reduce the number of quality-related problems in the future. According to the program office, the integration issues that have been discovered are not unusual for a first time integration effort but are taking more time than planned to work through. Upon completion of the first satellite's payload, the program office expects the cost and schedule variances to abate, although they will not recover. In addition, the second satellite's hardware has consistently moved through integration and testing much more efficiently than the first satellite's hardware. Thus, the program office still expects the prime contractor to deliver and launch the satellites in February 2007, which is earlier than the contract date, and has placed an order through NASA for the Delta II launch vehicle. Since our last assessment, STSS' planned budget through fiscal year 2009 increased by $1,195.9 million (35.3 percent), primarily in fiscal years 2008 and 2009, due to the addition of funds for designing and developing the program's operational constellation.

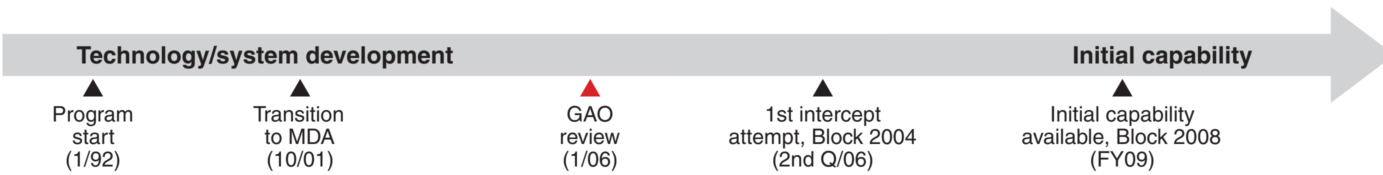
Agency Comments

MDA was provided an opportunity to comment on a draft of this assessment, but it did not have any comments.

Terminal High Altitude Area Defense (THAAD)

MDA's THAAD element is being developed in incremental, capability-based blocks to provide a ground-based missile defense system able to defend against short-and medium-range ballistic missile attacks. THAAD will include missiles, a launcher, an X-band radar, and a fire control and communications system. We assessed the design for the Block 2008 initial capability of one fire unit that MDA plans to hand off to the Army in fiscal year 2009 for limited operational use.

Source: Missile Defense Agency, THAAD Project Office.



Program Essentials

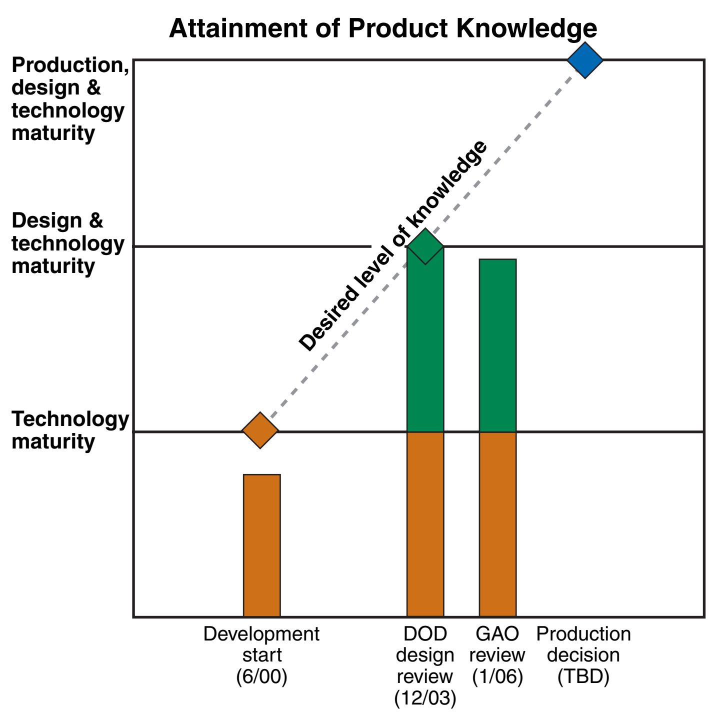
Prime contractor: Lockheed Martin
Program office: Huntsville, Ala.
Funding, FY06-FY11:
- R&D: $4,135.5 million
- Procurement: $0.0 million
- Total funding: $4,135.5 million
- Procurement quantity: 0

Program Performance (fiscal year 2006 dollars in millions)

	As of 09/2003	Latest 08/2005	Percent change
Research and development cost	$11,498.7	$12,045.1	4.8
Procurement cost	$0.0	$0.0	0.0
Total program cost	$11,498.7	$12,045.1	4.8
Program unit cost	TBD	TBD	TBD
Total quantities	TBD	TBD	TBD
Acquisition cycle time (months)	TBD	TBD	TBD

Costs are for all known blocks from the program's inception through fiscal year 2009. Total known program funding through fiscal year 2011 is $12,985.3 million.

Program officials assessed THAAD's technologies as mature and its design as generally stable, with 95 percent of the engineering design drawings released. The design of Block 2008, which is expected to provide a limited operational capability, is a further maturation of THAAD 's Block 2004 design. MDA began flight testing the design with a successful controlled test flight on November 22, 2005–8 months later than originally planned. According to program officials, the delay was the result of technical problems encountered during the integration of the THAAD missile, most of which have been solved. The current schedule is aggressive, calling for the completion of as many as five flight tests within one fiscal year. However, program officials expect to recover most of the flight schedule and complete 15 flight tests before handing the first fire unit over to the Army in fiscal year 2009.



THAAD Program

Technology Maturity

Program officials assessed all of THAAD's critical technologies as mature. All of these technologies are included in four major components: the fire control and communications component; the interceptor; the launcher; and the radar.

After experiencing early test failures, program officials made changes in the execution of the THAAD program that allowed it to make progress in maturing critical technologies. Officials placed more emphasis on risk reduction efforts, including adopting technology readiness levels to assess technological maturity.

Design Stability

Program officials reported that THAAD's basic design is nearing completion, with approximately 95 percent of the expected 9,852 engineering drawings released. However, if problems are encountered during future flight tests, the total number of drawings could increase.

Production Maturity

We did not assess THAAD's production maturity because MDA does not know when it will transition THAAD to the Army for production. The one fire unit that will be handed off to the Army in 2009 for limited operational use is considered to be primarily a test asset. Prior to a production decision, the program office plans to assess production maturity using risk assessments and verification reviews for assurance of the contractor's readiness to proceed with repeatable processes and quality.

Other Program Issues

MDA expected to begin flight tests in March 2005. However, because of technical problems experienced during the integration of the THAAD missile, the first test was pushed out to November 2005. The current schedule is aggressive, calling for the completion of as many as five flight tests within one fiscal year. However, program officials told us that most of the technical problems have been solved and that they are confident that they will recover most of the flight test schedule. The program expects to complete 15 flight tests before handing the first fire unit over to the Army in fiscal year 2009.

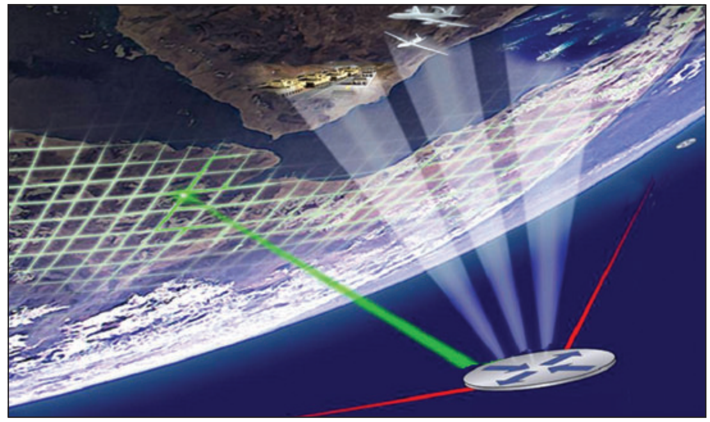
The problems incurred by the missile component also affected the program's cost performance. According to program officials, for the first time since its contract was awarded in 2000, the THAAD program is experiencing an unfavorable cumulative cost variance. Program officials noted that as of October 2005, the program was overunning its prime contract cost by approximately $50 million. Also, since our last assessment THAAD's planned budget through fiscal year 2009 has increased by $514.8 million (4.5 percent) primarily in fiscal years 2008 and 2009.

Agency Comments

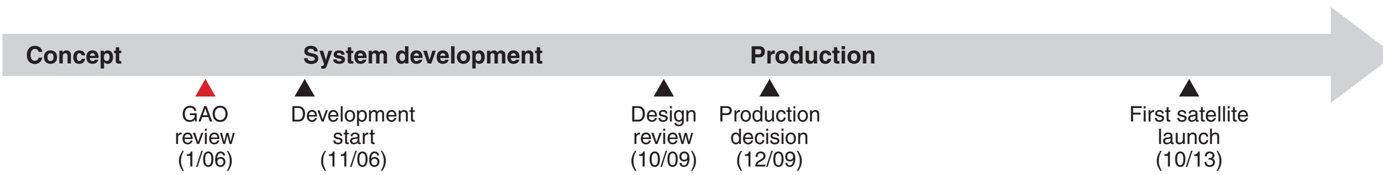
MDA provided technical comments, which were incorporated where appropriate.

Transformational Satellite Communications System (TSAT)

The Air Force's TSAT system is the space-borne element of the Global Information Grid that will provide high data rate military satellite communications services to DOD users. The system is designed to provide survivable, jam-resistant, global, secure, and general-purpose radio frequency and laser cross-links with other air and space systems. The TSAT system consists of a constellation of five satellites, plus a sixth satellite to ensure mission availability. We assessed the six satellites.



Source: Northrop Grumman Corporation.



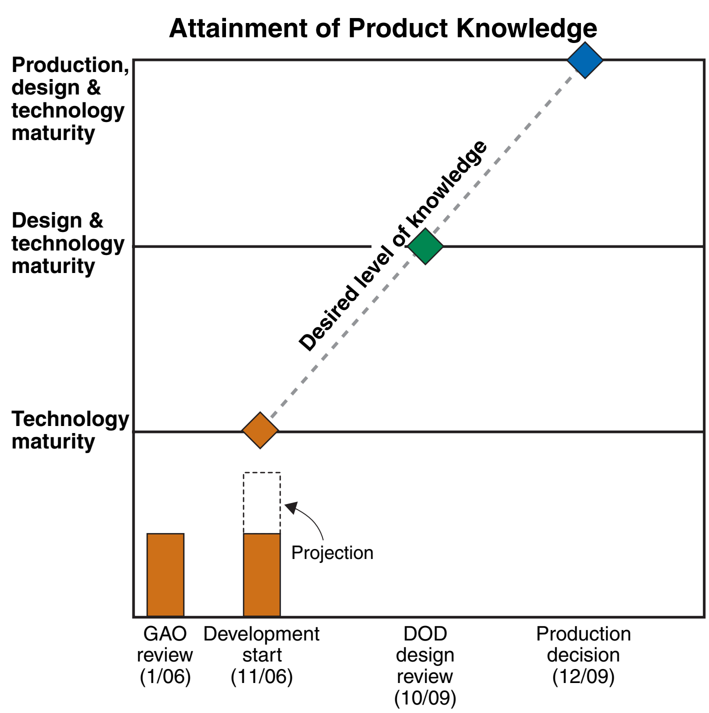
Program Essentials

Prime contractor: Boeing, Booz Allen Hamilton, Lockheed Martin Corp., Northrop Grumman, Raytheon
Program office: El Segundo, Calif.
Funding needed to complete:
R&D: $12,351.4 million
Procurement: $3,814.7 million
Total funding: $16,192.5 million
Procurement quantity: 4

Program Performance (fiscal year 2006 dollars in millions)

	As of NA	Latest 08/2005	Percent change
Research and development cost	NA	$13,273.2	NA
Procurement cost	NA	$3,814.7	NA
Total program cost	NA	$17,114.2	NA
Program unit cost	NA	$2,852.371	NA
Total quantities	NA	6	NA
Acquisition cycle time (months)	NA	147	NA

In January 2004, the TSAT program received formal approval to begin preliminary design development activities. To date, the program has focused on risk reduction and systems definition (e.g., requirements allocation and system design) leading to a planned Systems Design Review (SDR). The first launch schedule has been delayed by 24 months from its in initial approved program baseline in June 2004, as a result of 2005 congressional reductions and anticipated reductions in 2006. TSAT plans to begin product development activities for the first increment (two satellites) following SDR in November 2006 with all of its critical technologies mature, and at that time, a contract will be awarded to acquire operational satellites. According to program officials, a new acquisition strategy is being developed, which will result in a new program baseline, cost estimates, and schedule.



TSAT Program

Technology Maturity

In January 2004, DOD approved the TSAT program to enter the preliminary design phase. One of the program's nine technologies was fully mature. The program has focused its efforts on maturing critical technologies and conducting systems definition activities. System definition activities include requirements allocation and system design activities. According to program officials, product development activities will begin in November 2006 after a contractor is selected to conduct detailed design studies and development efforts. At that time, the program expects all critical technologies for the first increment to be mature.

Currently only four of its seven critical technologies are mature. However, program officials expect all critical technologies to be mature before initiating product development activities for the first increment in 2006.

Of the seven technologies, only four technologies--packet processing payload, communication-on-the-move antenna, information assurance space for internet protocol encryption and information assurance for transmission security--are mature. We previously identified information assurance as a single critical technology, but obtained more detailed data for this report. The other three--dynamic bandwidth and resource allocation, protected bandwidth efficient modulation waveforms, and single access laser communication--are scheduled to reach maturity in 2006, about 3 years after the approval to start preliminary design development activities.

Other Program Issues

The TSAT program cannot currently provide data on design stability, production maturity, or software development for satellite production because it has not yet selected a contractor to develop, build, and field the TSAT space segment. Contracting activities to select a single contractor are scheduled to begin in November 2006, with final award in early 2007.

The initial June 2004 program baseline had a first satellite launch scheduled for October 2011. The program office now estimates a first launch date of October 2013 and attributes the launch delay to appropriations reductions in fiscal year 2005 as well as anticipated reductions in fiscal year 2006. The Appropriations conferees reduced the program by $400 million due to concerns about the state of technology maturity and concerns that DOD may have prematurely ruled out the possibility of evolving the Advanced Extremely High Frequency and the Wideband Gapfiller System programs. The report also stated that transition to a formal acquisition program should be deferred until the TSAT technologies are mature and have been demonstrated in a relevant environment. The report requires that DOD submit the results of an independent review that: (1) determines whether additional Advanced Extremely High Frequency or Wideband Gapfiller System satellites will be required and how many; and (2) whether it is feasible to insert advanced capabilities by evolving these programs.

Agency Comments

In commenting on a draft of this assessment, the Air Force stated that the TSAT risk reduction and systems definition activities are on schedule. Currently the program is conducting the third independent evaluation of the contractor's laser communications subsystems, with the fourth and final tests scheduled for mid 2006. To date, all test goals have been met, according to the Air Force. Similar testing is being conducted on other key technologies, and all are on a path to be fully matured by late 2006. According to the Air Force, the program's first launch has been delayed from 2011 to late 2013 due to budget reductions. These delays have resulted in increased life cycle cost and account for the majority of the increases shown in this draft.

GAO Comment

In subsequent discussions, TSAT program officials stated that they are developing a new acquisition strategy, along with an updated baseline with new milestones, reflecting the $400 million congressional budget reduction.

V-22 Joint Services Advanced Vertical Lift Aircraft

The V-22 Osprey is a tilt rotor, short/vertical takeoff and landing aircraft being developed by the Navy for Joint Service application. Variants are designed to meet the amphibious/vertical assault needs of the Marine Corps, the strike rescue needs of the Navy, and the special operations needs of the Air Force and the U.S. Special Operations Command. The MV-22 version will replace the CH-46E and CH-53D helicopters of the Marine Corps. We assessed the MV-22 Block A. The Navy completed its operational evaluation of the aircraft in June 2005.

Source: U.S. Navy.

Concept | System development | Production

- Program start (12/82)
- Development start (4/86)
- Development restart (9/94)
- Full-rate decision (9/05)
- GAO review (1/06)
- Initial capability (3/07)
- Last procurement (2016)

Program Essentials

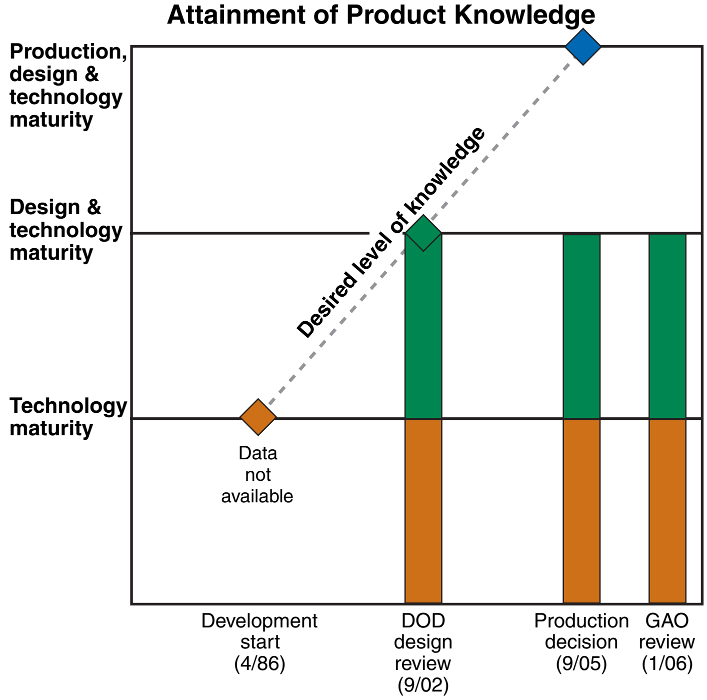
Prime contractor: Bell-Boeing JPO
Program office: Patuxent River, Md.
Funding needed to complete:
R&D: $1,010.4 million
Procurement: $27,357.1 million
Total funding: $28,407.1 million
Procurement quantity: 375

Program Performance (fiscal year 2006 dollars in millions)

	As of 04/1986	Latest 09/2005	Percent change
Research and development cost	$3,776.4	$11,687.4	209.5
Procurement cost	$31,634.9	$37,205.5	17.6
Total program cost	$35,621.6	$48,946.7	37.4
Program unit cost	$39.016	$106.871	173.9
Total quantities	913	458	-49.8
Acquisition cycle time (months)	117	291	148.7

Operational test and evaluation of MV-22 Block A has been completed, and the aircraft found to be operationally effective and suitable. Block B is predicted to have a drop in performance due to increased weight. Tests of Block A revealed deficiencies with the troop seat restraint system that has resulted in a redesign of the seat, which may require change to the aircraft structure to achieve desired seat crash retention capability. Also, flight clearance restrictions limited some aspects of testing, particularly survivability, defense maneuvers, and tactics. Deficiencies were identified with shipboard operations, passenger capability, and operations at altitude. In September 2005, the Department of Defense approved V-22 for full rate production; however, production aircraft continue to be accepted with numerous deviations and waivers.

Attainment of Product Knowledge



V-22 Program

Design Stability

The design of MV-22 Block A is considered stable. However, recent Block A operational evaluation tests identified deficiencies that could result in design changes to parts of the aircraft. Specifically, during operational tests the troop seat was considered a major deficiency and has been redesigned to address shoulder harness and comfort issues. In 2002, the Navy established a more crashworthy configuration requirement to be consistent with DOD and Federal Aviation Administration goals to meet common crash-worthiness standards for mission equipment. According to the program office, a change will be made to contract specifications to require these more stringent standards. Analysis is ongoing to determine if installation of these newly qualified seats will require aircraft structural changes to fully achieve their designed crash retention capability and what impact these changes would have on the aircraft's key performance parameters.

Production Maturity

In 2001, the V-22 was approved for a limited annual production rate. In September 2005, DOD approved the V-22 for full rate production even though a 2004 review found one contractor had parts production problems that could affect its ability to support full-rate production. Produced aircraft continue to be accepted with numerous deviations and waivers, but the number of deviations and waivers at acceptance are not now as significant as they have been in the past.

Other Program Issues

Based on evaluation tests, the Navy reported that the MV-22 Block A is operationally effective and suitable. However, the Navy's test report identified three major deficiencies that must be corrected and verified by additional operational tests. Of the three major deficiencies, troop seating and egress were considered the most severe. This deficiency required redesign of the seats to address comfort and seat restraint deficiencies. Also, while tests proved that the aircraft was capable of carrying 24 combat-equipped toops, it is anticipated that operational commanders will prefer that only 18 troops be carried in order to make room for their extra gear. Operational tests also identified 38 minor and 50 other deficiencies. Of the minor deficiencies, the need to eliminate flight clearance restrictions and increase the defensive-maneuvering envelope of the aircraft are a priority. Flight clearance restrictions limited some survivability, defensive maneuvers, and tactics testing and may reduce aircraft survivability if they are not lifted. The minor deficiencies identified could also affect operations. They include restricted shipboard operations, limits on operations above 10,000 feet altitude, passenger cabin cooling effectiveness, reliability problems with aircraft components, overheating of the drivetrain gearbox in hot weather, and the lack of supplemental oxygen for passengers that will restrict long-range mission profiles with troops on board.

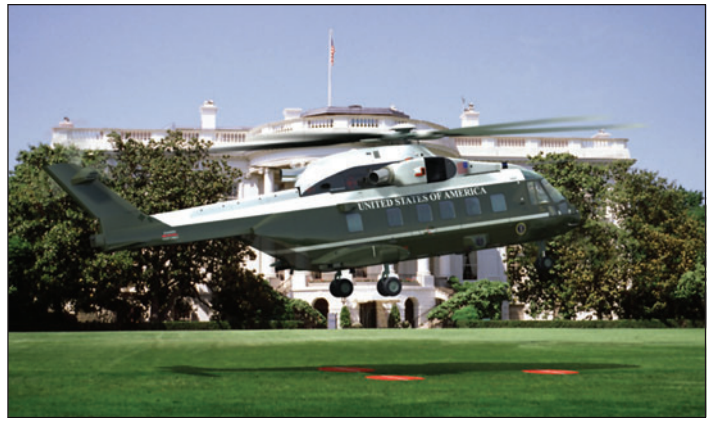
DOD has also concluded that the V-22 Block A aircraft is operationally effective in low and medium threat environments and is operationally suitable. However, DOD projects that Block B will not meet the Land Assault External-Lift and Amphibious External-Lift missions (key performance parameters). The predicted shortfall could be mitigated by lower aircraft weight, lower operating altitude, or lower temperatures. DOD's report does make a number of recommendations that address operational effectiveness and suitability as well as survivability concerns. Operational effectiveness recommendations included the need to conduct follow-on operational tests to assess V-22 survivability in realistic landing zone tactical approaches. These tests and tactics development are needed to expand the maneuvering flight envelope as much as possible and to determine whether there is operational utility in the use of more extreme helicopter-style maneuvering in a high-threat environment. Operational suitability recommendations included the need to implement upgrades to the passenger seats and harnesses. The report noted that emergency dual engine failures in the conversion/vertical take-off landing mode below 1,600 feet above the ground are unlikely to be survivable. Survivability recommendations included the need to install and test a defensive weapon.

Agency Comments

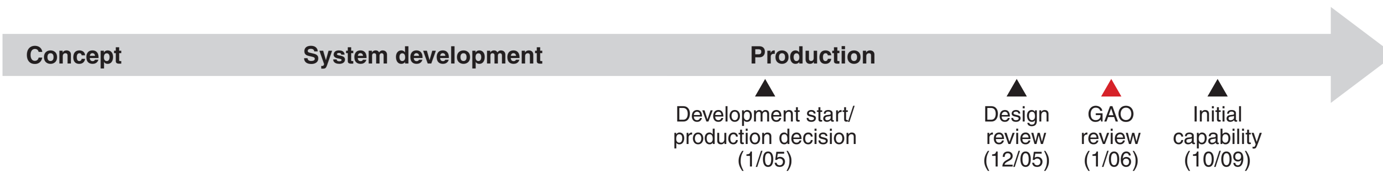
In commenting on a draft of this report, the V-22 program office provided technical comments, which were incorporated as appropriate.

VH-71A Presidential Helicopter Replacement Program

The Navy's VH-71A will be a dual-piloted, multi-engine helicopter employed by Marine Helicopter Squadron One to provide safe, reliable, and timely transportation for the President and Vice President of the United States, heads of state, and others in varied and at times adverse climatic and weather conditions. When the President is aboard, the VH-71A will serve as the Commander in Chief's primary command and control platform. The system will replace the VH-3D and VH-60N. It will be developed in two increments. We assessed increment one.



Source: VH-71A Program Office.



Program Essentials

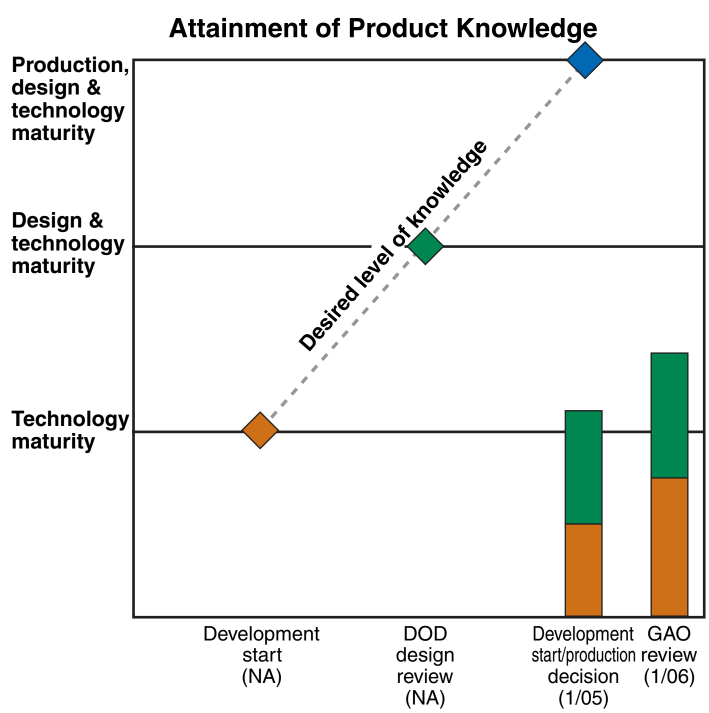
Prime contractor: Lockheed Martin Systems Integration
Program office: Patuxent River, Md.
Funding needed to complete:
R&D: $2,822.3 million
Procurement: $2,253.4 million
Total funding: $5,179.8 million
Procurement quantity: 23

Program Performance (fiscal year 2006 dollars in millions)

	As of NA	Latest 01/2005	Percent change
Research and development cost	NA	$3,577.4	NA
Procurement cost	NA	$2,253.3	NA
Total program cost	NA	$5,999.4	NA
Program unit cost	NA	$260.844	NA
Total quantities	NA	23	NA
Acquisition cycle time (months)	NA	57	NA

Program costs include costs for increments one and two.

In January 2005, the VH-71A program began system development and committed to production without fully maturing technologies, achieving design stability, or demonstrating production maturity. Program officials recognize that the VH-71A is a nontraditional acquisition with significant risks due to an aggressive schedule dictated by the White House in 2002. They stated that most of the system's technologies are nondevelopmental and are currently deployed on other platforms. However, neither of the VH-71A's two critical technologies were demonstrated in an operational environment at development start, and the program planned to have only 65 percent of its drawings released by design review. Concurrency in development, design, and production increases the likelihood of cost growth and schedule delays because components being procured may have to be reworked to meet the final design.



VH-71A Program

Technology Maturity

The VH-71A program's two critical technologies were nearing maturity when the program began development and committed to production in January 2005. Since then, one of those technologies, the 10-inch cockpit control displays, matured. A prototype of the other critical technology, the Communication and Subsystem Processing Embedded Resource Communications Controller, has not been flight tested and is not projected to be demonstrated in an operational environment until 2007. The program office believes the risk associated with fully maturing this technology to be low because the subsystem components that make up the technology are currently flying on other operational aircraft. Program officials stated that most of the VH-71A technologies were not identified as critical because they were flying on the EH-101 helicopter, on which the VH-71A is based.

Design Stability and Production Maturity

In January 2005, the program committed to the production of five aircraft without a final design or fully defined production processes. At that time, 55 percent of the program's total estimated drawings were releasable to manufacturing. Sixty-five percent were projected to be releasable by the design review in December 2005, and 80 percent were expected to be completed by early 2006, one year after the production decision. This concurrency in design and production increases the likelihood of cost growth and schedule delays because components being procured may have to be reworked to meet the final design. According to program officials, the drawings that have not been released are most likely related to modified communications and navigation systems and software. The program considers the design for the rest of the air vehicle and the production processes for the system mature because they are based on the EH-101, which is currently in service. However, design development will continue through low rate initial production as the program concurrently develops its manufacturing processes. The program will not collect statistical process control data to demonstrate production maturity, but it will monitor indicators, such as number of non-conforming products, quality notifications, hours per process, and scrap and rework rates.

Other Program Issues

The VH-71A program's aggressive schedule increases risk in the test program and negatively affects the program's ability to incorporate the insights gained from testing in increment one. To mitigate some of the schedule risk, the program has adopted a test philosophy that combines contractor, development, and operational testing. The Director, Operational Test and Evaluation, has not formally approved the program's test plans and is working with the program to make the plans more event-based and to develop metrics to measure progress.

Congressional insight into the program is currently limited because the program will not start reporting on progress against its cost, schedule, and performance baselines until June 2006, at the earliest. This reporting has been delayed because the program does not have an approved program baseline, even though the decision to start development and production was made in January 2005.

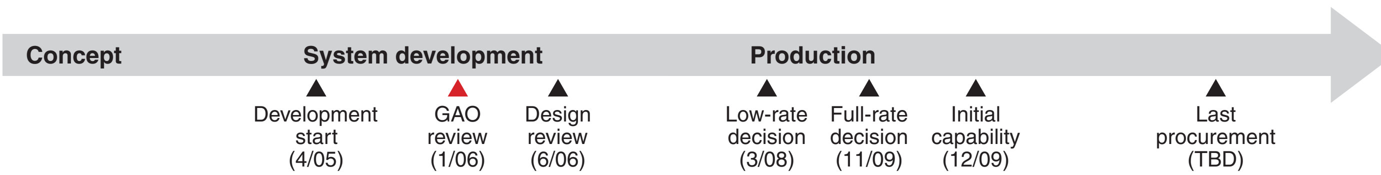
Agency Comments

In commenting on a draft of this assessment, the Navy provided technical comments, which were incorporated as appropriate. Additionally, the Navy stated that the program is executing an accelerated schedule driven by an urgent White House need to replace existing assets. It believes the GAO assessment does not emphasize the risk mitigation actions taken. Specifically, the incremental development approach minimizes risk through modification of a certified, fielded EH-101 to the VH-71 configuration, with high-risk items deferred to the second increment. According to the Navy, this approach allows the program to meet schedule requirements while mitigating acknowledged risks associated with concurrent design, development, and procurement. Use of an existing aircraft for increment one also takes advantage of established manufacturing, production, logistics, and training capabilities while reducing the requirements for flight test, and an aggressive integrated test approach maximizes early, robust testing, including operational tests. Deferring high-risk development work to increment two provides time to accomplish design, development, and test activities associated with more traditional development programs.

Warrior Unmanned Aerial Vehicle (Warrior UAV)

The Army's Extended Range Multipurpose Unmanned Aerial Vehicle, now called Warrior, is to replace the Hunter Unmanned Aerial Vehicle. A system is composed of 12 air vehicles, and 5 ground control stations with associated ground data terminals and portable control stations. The system is expected to provide reconnaissance, communications, signal intelligence, lethal and nonlethal attack and interoperability with manned aviation assets such as Apache and the Advanced Reconnaissance Helicopter.

Source: UAVS Project Office.



Program Essentials

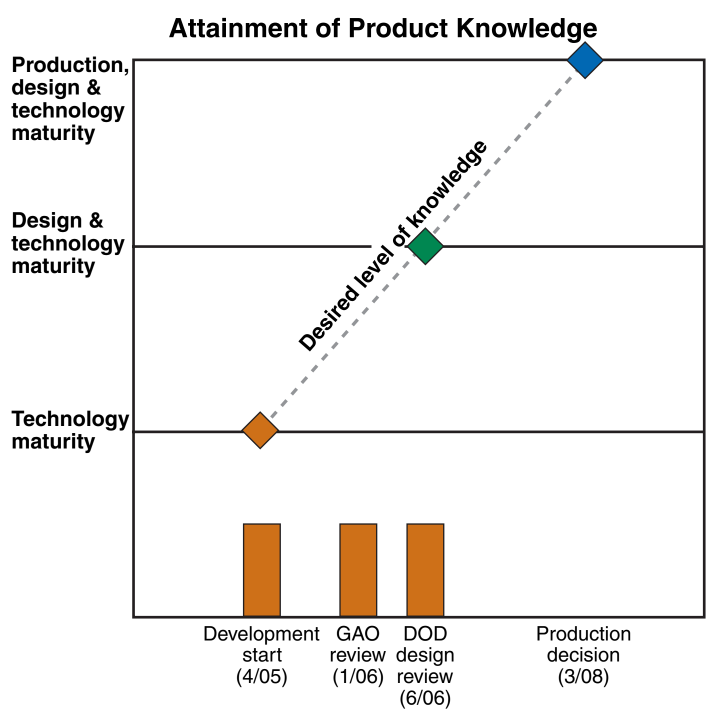
Prime contractor: General Atomics
Program office: Huntsville, Ala.
Funding needed to complete:
R&D: $276.7 million
Procurement: $1,443.8 million
Total funding: $1,720.6 million
Procurement quantity: 12

Program Performance (fiscal year 2006 dollars in millions)

	As of 04/2005	Latest 12/2005	Percent change
Research and development cost	$306.3	$300.1	-2.0
Procurement cost	$595.4	$1,443.8	142.5
Total program cost	$901.7	$1,744.0	93.4
Program unit cost	$180.337	$145.330	-19.4
Total quantities	5	12	140.0
Acquisition cycle time (months)	50	56	12.0

Cost and quantities include all known quantities from program inception through fiscal year 2015.

Currently two of Warrior's four critical technologies are mature. The program expects to have matured the other two critical technologies by the time of the program's design readiness review in June 2006. However, if these technologies do not mature in time, the Army reports that it has two mature back up technologies that can be used in their place. General Atomics, which makes the Air Force Predator UAV, is the prime contractor for the Warrior UAV. Program officials estimate that about 90 percent of Warrior's design is nondevelopmental because it is already in use on Predator or other systems.



Warrior UAV Program

Technology Maturity

Program officials report that two of four critical technologies are mature. These technologies are the heavy fuel engine, which is certified by the Federal Aviation Administration, and the automatic take-off and landing system whose technology is based on a similar system in use on the Hunter and other unmanned aerial vehicle systems. The two remaining critical technologies, the airborne ethernet and the multirole tactical common data link, are expected to reach maturity before the June 2006 design readiness review.

The airborne ethernet provides communications capabilities among the avionics, the payload data recorder, the air link data units and the payloads and weapons systems. The technology will permit transmission of live data rather than time-delayed data. Program officials assess risk to the program associated with this technology as low because a mature back-up technology exists and because the interfaces for the system--such as payloads and the support equipment package, the payload data recorder and the meteorological sensor--are in place. Further, officials stated that Warrior's design is similar to that of the Air Force Predator A, which is already fielded.

The multirole tactical common data link is being developed to support data transmission at higher rates, provide interoperability with other systems, such as the Apache, and provide for controlling the air vehicle itself from other platforms. According to Army officials, the technology is based on an Army program that is currently running 6 months ahead of the schedule needed for introduction to the Warrior system. Similar to the airborne ethernet, a tactical data link currently exists on other systems and could be used for the Warrior to provide a capability but at a slower rate and offering remote control of the payloads though not the entire vehicle.

Design Stability

The Warrior UAV program office did not provide complete data on the number of drawings expected or currently completed. As a result, we could not assess current design maturity. Program officials did estimate, however, that 90 percent of the system's design was non-developmental and is already in use in the Predator or other systems. As a result, the Army expects design stability by the time of the design review in June 2006.

Other Program Issues

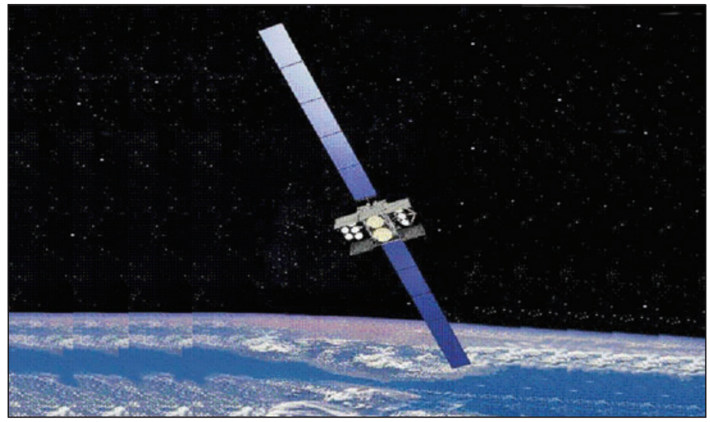
Cost and quantity data reported in this assessment may change. The Army has not decided how many Warrior systems it will buy. Since approving development start in April 2005, the Army has increased the number it plans to buy from 5 to 12 through fiscal year 2015. For this review, the Army provided data on cost and quantities and its funding plan through fiscal year 2015. However, program office officials stated that the Army has not decided how many Warrior systems it will buy in total nor how long the system will be produced.

Agency Comments

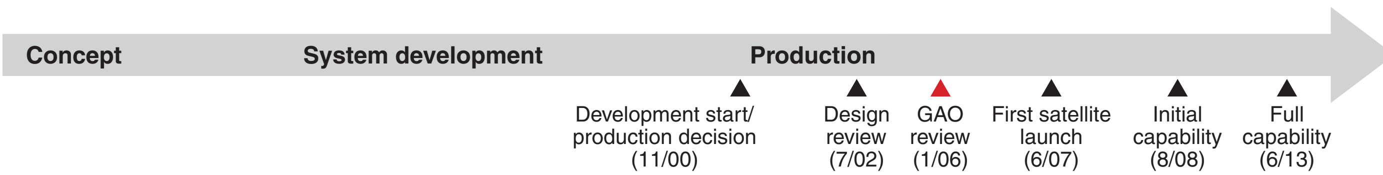
The program office provided technical comments, which we incorporated as appropriate. Program office officials also stated that the Warrior design utilizes basic airframe technology from the Predator A, but also borrows from the Predator B design. Warrior's design is tied to the Apache Block III (manned-unmanned teaming) and Future Combat Systems as a network enabler.

Wideband Gapfiller Satellites (WGS)

WGS is a joint Air Force and Army program intended to provide essential communications services to U.S. warfighters, allies, and coalition partners during all levels of conflict short of nuclear war. It is the next generation wideband component in DOD's future Military Satellite Communications architecture and is composed of the following principal segments: space segment (satellites), terminal segment (users), and control segment (operators). We assessed the space segment.



Source: WGS Program Office.



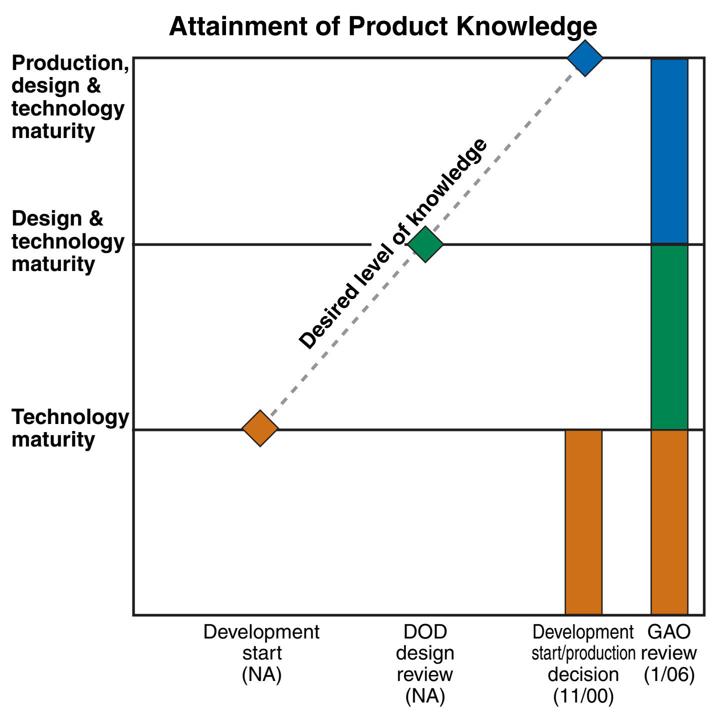
Program Essentials

Prime contractor: Boeing Satellite Systems
Program office: El Segundo, Calif.
Funding needed to complete:
- R&D: $118.6 million
- Procurement: $786.2 million
- Total funding: $904.8 million
- Procurement quantity: 2

Program Performance (fiscal year 2006 dollars in millions)

	As of 12/2000	Latest 02/2006	Percent change
Research and development cost	$189.9	$324.0	70.6
Procurement cost	$869.3	$1,481.4	70.4
Total program cost	$1,059.2	$1,805.5	70.5
Program unit cost	$353.075	$361.092	2.3
Total quantities	3	5	66.7
Acquisition cycle time (months)	50	93	86.0

The WGS program's technology and design are mature. We did not review production maturity data because of the commercial nature of the WGS acquisition, but unit level manufacturing is essentially complete. The contractor continues to experience problems assembling the satellites. Improperly installed fasteners on a satellite subcomponent have resulted in rework on the first satellite and extensive inspections of all three satellites currently being fabricated. The program office estimates an increase of about $276.2 million for the program, largely due to cost growth resulting from a production gap between satellites three and four. The launch of the first satellite has now been delayed for over 3 years and is currently scheduled for June 2007. The delay will increase costs and add at least 22 months to the time it takes to obtain an initial operational capability from the system.



WGS Program

Technology Maturity

WGS has two technologies that are vital to program success: the digital channelizer and the phased array antenna. According to program officials, both technologies were mature when the program made a production decision in November 2000.

Design Stability

The WGS design is complete, as the program office has released all the expected drawings to manufacturing.

Production Maturity

The commercial nature of the WGS acquisition contract precludes the program office from having access to production process control data. However, manufacturing for WGS is essentially complete, as all the units have been manufactured and delivered for the first satellite.

Although the design for WGS is mature and development of the first satellite is complete, the program continues to experience problems assembling the satellites. For example, during the replacement of a subcomponent on the first satellite, it was discovered that certain fasteners had been improperly installed. Discovery of the problem resulted in extensive inspections on all three satellites currently being fabricated, with rework required on the first satellite. In all, 148 fasteners have been found that required rework and over 1,500 fasteners per satellite required additional inspection or testing. The testing is expected to be completed in the summer of 2006. According to program officials, the contractor is considering initiatives to improve oversight to avoid similar problems in the future.

Other Program Issues

Last year we reported a December 2005 launch date for the first WGS satellite. This date slipped to March 31, 2006, because of a launch pad conflict with a higher priority national security satellite. At that time, the program office reported that the initial operational capability would not be impacted by the schedule slip. However, the launch slipped again when the fastener issue surfaced. The launch of the first satellite is now scheduled for June 2007. The program office reports that the 15-month slip in the schedule for all three satellites will add workforce and rework costs (borne by the contractor) to the program and delay the time it takes to obtain an initial operational capability by 22 months.

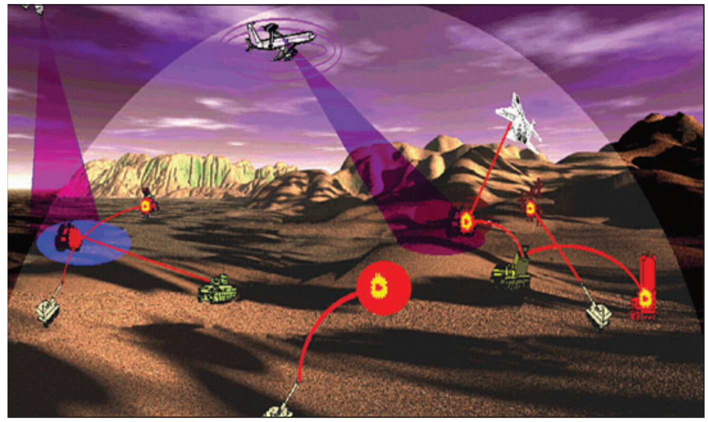
In December 2002, DOD directed the addition of WGS satellites four and five as part of the Transformational Communications Architecture. The purpose of these satellites will be to support increased bandwidth required for the Airborne Intelligence, Surveillance, and Reconnaissance mission. These satellites are to launch in fiscal years 2009 and 2010, respectively. The current contract options must be extended and renegotiated to cover the cost of the likely 2- to 3-year production gap between satellites three and four. The program office has selected a contractor and is currently negotiating the final contract price for procuring satellites four and five. Preliminary estimates show that the production gap is the main driver of the total overall cost increase of about $276.2 million for the program. Because of the delays in the schedule for the first three satellites, the program office is working with the contractor to reassess the schedule for satellites four and five. The results could impact the full operational capability date for the system.

Agency Comments

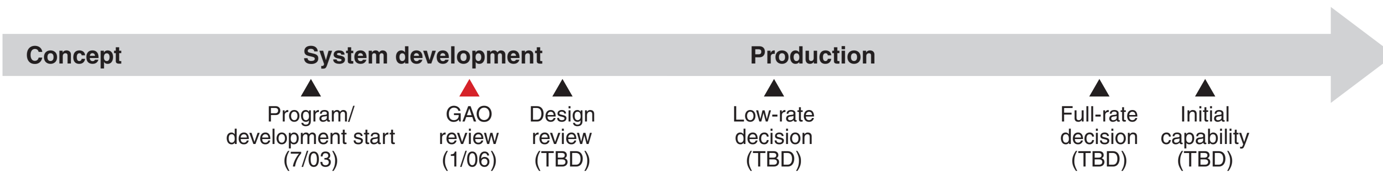
In commenting on a draft of this assessment, the program office stated that rework activities associated with the 148 improperly installed fasteners have been completed and additional inspection and testing of the remaining fasteners will be completed in 2006. The program office also stated that the government and contractor are instituting increased levels of oversight on the supplier's quality management program to avoid these types of problems on future satellites.

Warfighter Information Network-Tactical (WIN-T)

WIN-T is the Army's high-speed and high-capacity backbone communications network. It is to provide reliable, secure, and seamless video, data, imagery, and voice services, allowing users to communicate simultaneously at various levels of security. WIN-T is to connect Army units with higher levels of command and provide Army's tactical portion of the Global Information Grid. WIN-T is being fielded in blocks. We assessed the first block.



Source: PM WIN-T.



Program Essentials

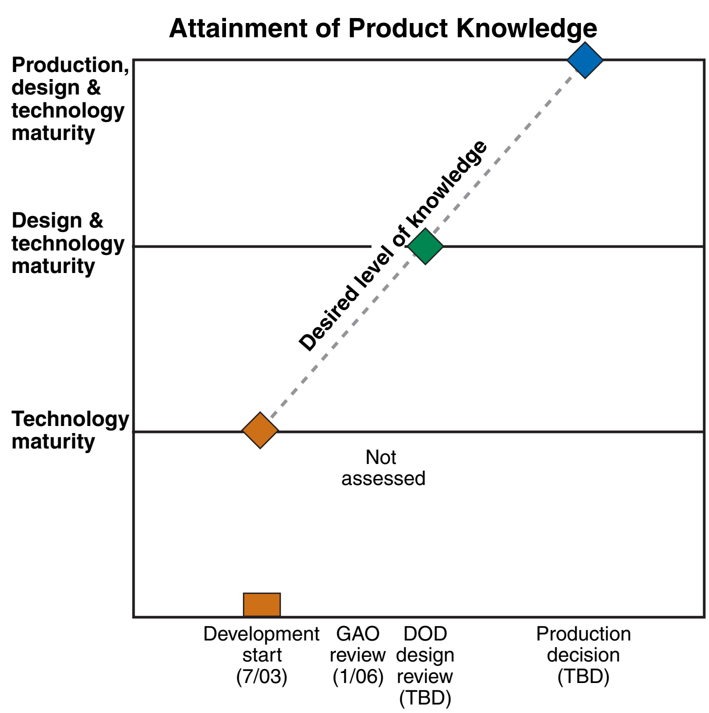
Prime contractor: General Dynamics Government Systems Corp.
Program office: Ft. Monmouth, N.J.
Funding needed to complete:
R&D: $505.9 million
Procurement: $10,002.4 million
Total funding: $10,508.4 million
Procurement quantity: 1

Program Performance (fiscal year 2006 dollars in millions)

	As of 07/2003	Latest 12/2005	Percent change
Research and development cost	$755.2	$755.2	0.0
Procurement cost	$9,713.7	$10,002.4	3.0
Total program cost	$10,468.9	$10,757.6	2.8
Program unit cost	$10,468.879	$10,757.640	2.8
Total quantities	1	1	0.0
Acquisition cycle time (months)	78	TBD	TBD

The latest cost data reflect the program of record; these data are expected to change as part of the program's restructuring.

WIN-T entered system development with 3 of its 12 critical technologies nearing maturity. While these 12 technologies will not be fully mature at the time production begins, some were demonstrated during a recent developmental test/operational test event; the program office expects that all 12 will be assessed as nearing maturity based on an updated independent technology readiness assessment that will be completed in preparation for a milestone B "re-look" scheduled for August 2006. While design stability is evaluated during WIN-T's design reviews, it cannot be assessed using our methodology because the program office does not track the number of releasable drawings. However, the government will require the contractor to deliver critical Interface Control Design documents, which, according to the program office, will allow tracking of design stability by an independent assessor.



WIN-T Program

Technology Maturity

WIN-T entered system development with 3 of its 12 critical technologies close to reaching full maturity. While program officials do not expect these 12 technologies to reach full maturity until the network is built and can be demonstrated in an operational environment, some of the technologies were demonstrated in a relevant environment during a developmental test/operational test event in November 2005; the Army Test and Evaluation Command will complete its assessment of this event by April 2006. The WIN-T program office expects that all 12 critical technologies will be assessed as close to fully mature following the evaluation of results from this test event. An updated independent technology readiness assessment will be performed in preparation for what the program office has described as a WIN-T milestone B "re-look" currently scheduled for August 2006. This updated assessment will include demonstration results from the developmental test/operational test event.

Design Stability

Design stability could not be assessed using our methodology because the program office does not plan to track the number of releasable drawings as a design metric. According to the program, WIN-T is not a manufacturing effort, but primarily an information technology system integration effort. Consequently, the government does not obtain releasable design drawings for many of WIN-T's components, particularly commercial components. Instead, design stability is evaluated at the preliminary and critical design reviews using the exit criteria developed by the government. For the milestone B "re-look," the government will require the contractor to deliver critical Interface Control Design documents which, according to the program office, will allow tracking of design stability by an independent assessor. According to DOD, the WIN-T design will evolve using performance-based specifications and open systems design and is to conform to DOD's Joint Technical Architecture, which specifies the minimun set of standards and guidance for the acquisition of all DOD systems that produce, use, or exchange information.

Other Program Issues

A major revision to the WIN-T acquisition strategy was completed in 2004. In September 2004, DOD approved a decision to combine the competing contractor teams for WIN-T's system design and development. The two originally competing contractors are now teamed to establish a single architecture for WIN-T that, according to the revised acquisition strategy, will leverage each contractor's proposed architecture to provide the Army with a superior technical solution for WIN-T. Establishing the single WIN-T architecture a year earlier than originally planned is expected to allow other Army programs to begin following that architecture for the Future Force.

The global war on terrorism and the lessons learned from recent military operations have shifted the Army's focus toward providing improved communications and networking capabilities in the near term as well as for the Future Force. The Army fielded a beyond-line-of-sight communications network system in 2004 to units deployed in Iraq: the Joint Network Node. This system is an improvement over past capabilities, but does not meet all of WIN-T's requirements -- particularly for on-the-move communication. Currently, the Army is assessing how best to transition the Joint Network Node to WIN-T.

Also, in August 2005, the Department of the Army conducted a study that explored options for better synchronizing three of its major system development efforts--WIN-T, the Future Combat Systems, and the Joint Tactical Radio System program. As a result of this study, the WIN-T program will be rebaselined to meet emerging requirements; a new WIN-T capability development document that will support the rebaselining of the program is currently under review. A milestone B "re-look" to rebaseline the program is planned for August 2006, and a new date for the WIN-T production decision, originally scheduled for March 2006, will be established then.

Agency Comments

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

Agency Comments

DOD did not provide general comments on a draft of this report, but it did provide technical comments. These comments, along with agency comments received on the individual assessments, were included as appropriate. (See app. I for a copy of DOD's response.)

Scope of Our Review

For the 52 programs, each assessment provides the historical and current program status and offers the opportunity to take early corrective action when a program's projected attainment of knowledge diverges significantly from the best practices. The assessments also identify programs that are employing practices worthy of emulation by other programs. If a program is attaining the desired levels of knowledge, it has less riskbut not zero risk-of future problems. Likewise, if a program shows a gap between demonstrated knowledge and best practices, it indicates an increased risk-not a guarantee-of future problems. The real value of the assessments is recognizing gaps early, which provides opportunities for constructive intervention-such as adjustments to schedule, trade-offs in requirements, and additional funding-before cost and schedule consequences mount.

We selected programs for the assessments based on several factors, including (1) high dollar value, (2) stage in acquisition, and (3) congressional interest. The majority of the 52 programs covered in this report are considered major defense acquisition programs by DOD. A program is defined as major if its estimated research and development costs exceed $365 million or its procurement exceeds $2.19 billion in fiscal year 2000 constant dollars. (See app. II for details of the scope and methodology.)

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

If you have any questions on this report, please contact me at (202) 512-4841 or Paul Francis at (202) 512-4841. Major contributors to this report are listed in appendix IV.

Katherine V. Schinasi
Managing Director
Acquisition and Sourcing Management

List of Congressional Committees

The Honorable John W. Warner
Chairman
The Honorable Carl Levin
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Ted Stevens
Chairman
The Honorable Daniel K. Inouye
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Duncan Hunter
Chairman
The Honorable Ike Skelton
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable C. W. Bill Young
Chairman
The Honorable John P. Murtha
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

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 0 6 2006

Mr. Paul Francis
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Francis:

This is the Department of Defense response to the GAO draft report, *Defense Acquisitions: Assessments of Major Weapon Programs*, dated February 9, 2006 (GAO Code 120460/GAO-06-391). We have enclosed technical comments to ensure accuracy. These comments should be reflected in the final report and in the individual program summaries. My point of contact is Mr. Skip Hawthorne, (703) 692-9556, or e-mail: skip.hawthorne@osd.mil.

Sincerely,

Domenic C. Cipicchio

Domenic C. Cipicchio
Acting Director, Defense Procurement
and Acquisition Policy

Enclosure:
As stated

Scope and Methodology

In conducting our work, we evaluated performance and risk data from each of the programs included in this report. We summarized our assessments of each individual program in two components—a system profile and a product knowledge assessment. We did not validate the data provided by the Department of Defense (DOD). However, we took several steps to address data quality. Specifically, we reviewed the data and performed various quality checks, which revealed some discrepancies in the data. We discussed the underlying data and these discrepancies with program officials and adjusted the data accordingly. We determined that the data provided by DOD were sufficiently reliable for our engagement purposes, after reviewing DOD's management controls for assessing data reliability.

Macro Analysis

Data for the total planned investment of major defense acquisition programs were obtained from funding-stream data included in DOD's selected acquisition reports or from data obtained directly from the program offices and then aggregated across all programs in base year 2006 dollars.

To assess the total cost, schedule, and quantity changes of the programs included in our assessment presented in table 2 and on pages 6 and 7, it was necessary to identify those programs with all of the requisite data available. Of the 52 programs in our assessment, 26 constituted the common set of programs where data were available for cost, schedule, and quantity at the first full estimate, generally milestone B, and the latest estimate. We excluded programs that had planning estimates as their first full estimate and if the first full estimate and latest estimate fell within a one year period of each other. Data utilized in this analysis were drawn from information contained in selected acquisition reports or data provided by program offices as of January 15, 2006. We summed the costs associated with RDT&E and total costs consisting of research, development, testing and evaluation, procurement, military construction, and acquisition operation and maintenance. The schedule assessment is based on the change in the average acquisition cycle time, defined as the number of months between program start and the achievement of initial operation capability or an equivalent fielding date.

The weighted calculations of acquisition cycle time and program acquisition unit cost for the common set of programs were derived by taking the total cost estimate for each of the 26 programs and dividing it by the aggregate total cost of all 26 programs in the common set. The resulting quotient for each program was then multiplied by the simple percentage change in program acquisition unit costs to obtain the weighted unit cost change of each program. Next, the sum of this weighted cost change for all programs was calculated to get the weighted unit cost change for the common set as a whole. To assess the weighted-average acquisition cycle time change, we multiplied the weight calculation by the acquisition cycle time estimate for each corresponding program. A simple average was then taken to calculate the change between the first full estimate and the latest estimate. We believe these calculations best represent the overall progress of programs by placing them within the context of the common set's aggregate cost.

To assess the percentage of programs with technology maturity, design stability, and production maturity at each key juncture presented in figure 1 and on pages 11 and 12, we identified programs that had actually proceeded through each key juncture–development start, system design review, and production start–and obtained their assessed maturity. The percentage in figure 1 and on pages 11 and 12 include programs in the 2006 assessment only. The population size for the technology maturity at development start is 30 programs; design review is 21 programs; and production start is 15 programs. The population size for the design stability at design review is 20 programs; and 12 programs at production start. The population size for production maturity at production start is 16 programs. This information was drawn from data provided by the program office as of January 15, 2006. For more information, see the product knowledge assessment section in this appendix.

Historical Analysis

For the historical RDT&E cost growth analysis in figure 2, we selected programs that have completed 100 percent of their product development cycle–defined as the period of time between the start of the system development and demonstration phase and the start of production. We identified 29 programs that are now in production or have been completed since 1998. We reviewed information provided in DOD's Selected Acquisition Reports (SARs) or through schedule information we obtained from program officials via our assessments to determine which programs are complete and which ones are in production. We also reviewed the DOD Selected Acquisition Report Summary tables to identify completed programs. We chose completed programs that had a final SAR report month of December 1998 or later. We also chose programs that only had a development estimate baseline rather than a production estimate baseline because we could then calculate an associated product development cycle time.

Development start refers to the commitment to system development that coincides with either milestone II or milestone B, which begins DOD's system development and demonstration phase. The product development cycle concludes with production. The production decision generally refers to the decision to enter the production and deployment phase, typically with low rate initial production. To identify the conclusion of the cycle, or development end, we first attempted to establish the date of the low rate initial production decision. If this date was not available we then used the milestone C or III date, or the production estimate date. We identified these dates using the latest SAR for each individual program or through schedule information obtained from program officials via our assessments. Once the product development cycle dates were identified, we then converted the time between the two dates into a number of months for each program.

For each of the 29 programs in our analysis, we identified the RDT&E development estimate and each subsequent estimate of RDT&E costs throughout the product development cycle by reviewing each of the program's SAR. Each SAR report date was then used in calculating the percentage into the product development cycle where the estimate fell. Once these calculations were completed for each of the 29 programs, we aggregated the RDT&E estimates at each percentage point from 1 to 100 percent. The end result was the cumulative cost change in 2006 dollars for 29 programs from the development estimate with a cost change plotted for each point from 1 to 100 percent complete. For example, the AIM 9X Air to Air Missile's product development cycle was 45 months. The development estimate for RDT&E was $602.2 million in December 1996. The first SAR after development start was the December 1997 SAR, which reported an RDT&E estimate of $589.9 million (2006 dollars). The December 1997 SAR was 12 months into development or approximately 27 percent into the product development cycle. Since estimates are reported on an annual basis, the initial development estimate for the AIM-9X was carried through up to 26 percent of the cycle time, the 1997 SAR estimate was then plotted at 27 percent and carried through up to the next reporting period, December 1998, which was plotted at 53 percent and so forth until 100 percent of the cycle time was completed. Once this was completed for all programs, we were able to identify the RDT&E cost growth trend for all 29 programs.

To identify the average critical design review date we obtained the latest date as reported in the program's latest SAR or as provided to us via our program assessments. If the critical design review date was not included in the SAR, we attempted to contact the current program manager and obtain the date. We were able to identify 21 critical design review dates for the 29 programs. Once this date was identified, we calculated the percentage into the development cycle the critical design review occurred. For example, the AIM-9X SAR reported that the critical design review took place in March of 1998, approximately 15 months, or 33 percent, into the 45 month development cycle. Next, we calculated a weighted average design review date for the 21 programs. The weighted calculations were derived by taking the latest RDT&E cost estimate at the completion of the product development cycle for each of the 21 programs and dividing it by the sum of all 21 programs. The resulting quotient for each program was then multiplied by the percentage into the product development cycle when the design review occurred. This resulted in a weighted calculation that was then summed across all 21 programs. The result was the weighted average design review percentage.

The maximum RDT&E increase for the 21 design review programs was 129.10 percent for the V-22 program. The minimum RDT&E increase for the 21 programs was -15.9 percent for the Joint Primary Aircraft Training System. The graphic on page 14 displays the RDT&E cost trend for all 29 programs and is not limited to the 21 programs with design review dates. We found the same trend of RDT&E cost growth occurred for the 29 programs as for the 21 programs.

System Profile Data on Each Individual Two-Page Assessment

In the past 5 years, DOD revised its policies governing weapon system acquisitions and changed the terminology used for major acquisition events. To make DOD's acquisition terminology more consistent across the 52 program assessments, we standardized the terminology for key program events. In the individual program assessments, program start refers to the initiation of a program; DOD usually refers to program start as milestone I or milestone A, which begins the concept and technology development phase. Similarly, development start refers to the commitment to system development that coincides with either milestone II or milestone B, which begins DOD's system development and demonstration phase. The production decision generally refers to the decision to enter the production and deployment phase, typically with low rate initial production. Initial capability refers to the initial operational capability, sometimes also called first unit equipped or required asset availability. For the MDA programs that do not follow the standard DOD acquisition model, but instead develop systems in incremental capability-based blocks, we identified the key technology development efforts that lead to an initial capability for the block assessed.

The information presented on the funding needed to complete from fiscal 2006 through completion, unless otherwise noted, draws on information from SARs or on data from the program office. In some instances the data were not yet available, and we annotate this by the term "to be determined" (TBD), or not applicable, annotated (NA). The quantities listed only refer 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.

To assess the cost, schedule, and quantity changes of each program, we reviewed DOD's SARs or obtained data directly from the program offices. In general, we compared the latest available SAR information with a baseline for each program. For programs that have started product development-those that are beyond milestone II or B-we compared the latest available SAR to the development estimate from the first selected acquisition report issued after the program was approved to enter development. For systems that have not yet started system development, we compared the latest available data to the planning estimate issued after milestone I or A. For systems not included in SARs, we attempted to obtain comparable baseline and current data from the individual program offices. For MDA systems for which a baseline was not available, we compared the latest available cost information to the amount reported last year.

All cost information is presented in base year 2006 dollars using Office of the Secretary of Defense approved deflators to eliminate the effects of inflation. We have depicted only the programs' main elements of acquisition cost-research and development and procurement; however, the total program costs also include military construction and acquisition operation and maintenance costs. Because of rounding and these additional costs, in some situations the total cost may not match the exact sum of the research and development and procurement costs. The program unit costs are calculated by dividing the total program cost by the total quantities planned. These costs are often referred to as program acquisition unit costs. In some instances, the data were not applicable, and we annotate this by using the term "NA." In other instances, the current absence of data on procurement funding and quantities precludes calculation of a meaningful program acquisition unit cost, and we annotate this by using the term "TBD." The quantities listed refer to total quantities, including both procurement and development quantities.

The schedule assessment is based on acquisition cycle time, defined as the number of months between the program start, usually milestone I or A, 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 TBD, or were classified.

The intent of these comparisons is to provide an aggregate or overall picture of a program's history. These assessments represent the sum total 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 Each Individual Two-Page Assessment

To assess the product development knowledge of each program at key points in development, we submitted a data collection instrument to each program office. The results are graphically depicted in each two-page assessment. We also reviewed pertinent program documentation, such as the operational requirements document, the acquisition program baseline, test reports, and major program reviews.

To assess technology maturity, we asked program officials to apply a tool, referred to as technology readiness levels, for our analysis. The National Aeronautics and Space Administration originally developed technology readiness levels, 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. Technology readiness levels are measured on a scale of one to nine, beginning with paper studies of a technology's feasibility and culminating with a technology fully integrated into a completed product. (See app. III for the definitions of technology readiness levels.) Our best practices work has shown that a technology readiness level of 7—demonstration of a technology in an operational environment—is the level of technology maturity that constitutes a low risk for starting a product development program. In our assessment, the technologies that have reached technology readiness level 7, a prototype demonstrated in an operational environment, are referred to as mature or fully mature and those that have reached technology readiness level 6, a prototype demonstrated in a relevant environment, are referred to as approaching or nearing maturity and are assessed as attaining 50 percent of the desired level of knowledge. Satellite technologies that have achieved technology readiness level 6 are assessed as fully mature due to the difficulty of demonstrating maturity in an operational environment–space.

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 technology readiness levels in those cases where information existed that raised concerns. If we were to conduct a detailed review, we might adjust the critical technologies assessed, the readiness level 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.

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

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. In most cases, we did not verify or validate this information provided by the program office. We sought to clarify the number of critical manufacturing processes and percentage of statistical process control where information existed that raised concerns. We used a standard called the Process Capability Index, which is 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 sought other data, such as scrap and rework trends, in those cases where quantifiable statistical control data were unavailable.

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 for a fuller treatment of risk elements.

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 operational environment.	Prototype—Should be very close to form, fit and function. Probably includes the integration of many new components and realistic supporting elements/subsystems if needed to demonstrate full functionality of the subsystem.	High-fidelity lab demonstration or limited/restricted flight demonstration for a relevant environment. Integration of technology is well defined.
7. System prototype demonstration in an operational environment.	Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in an operational environment, such as in an aircraft, vehicle or space. Examples include testing the prototype in a test bed aircraft.	Prototype. Should be form, fit and function integrated with other key supporting elements/subsystems to demonstrate full functionality of subsystem.	Flight demonstration in representative operational 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	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	OT&E in operational mission conditions

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

GAO Contact and Acknowledgments

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Advanced Extremely High Frequency Satellites (AEHF)	Bradley L. Terry
Active Electronically Scanned Array Radar (AESA)	Joseph E. Dewechter/Jerry W. Clark
Advanced Precision Kill Weapon System (APKWS)	Michele R. Williamson/Wendy P. Smythe
Advanced SEAL Delivery System (ASDS)	Mary K. Quinlan
Advanced Threat Infrared Countermeasure/Common Missile Warning System (ATIRCM/CMWS)	Danny G. Owens/Leon S. Gill
B-2 Radar Modernization Program (B-2 RMP)	Don M. Springman/Andrew H. Redd
C-130 Avionics Modernization Program (C-130 AMP)	Marvin E. Bonner/Sean D. Merrill
C-5 Avionics Modernization Program (C-5 AMP)	Cheryl K. Andrew/Sameena N. Ismailjee
C-5 Reliability Enhancement and Reengining Program (C-5 RERP)	Sameena N. Ismailjee/Cheryl K. Andrew
CH-47F Improved Cargo Helicopter (CH-47F)	Wendy P. Smythe/ Danny G. Owens
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(Continued From Previous Page)

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E-2 Advanced Hawkeye (E-2 AHE)	Gary L. Middleton/Judy T. Lasley
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Excalibur Precision Guided Extended Range Artillery Projectile	John P. Swain/Carrie R. Wilson
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Source: GAO.

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