United States General Accounting Office

GAO

Report to Congressional Committees

March 2004

DEFENSE ACQUISITIONS

Assessments of Major Weapon Programs

GAO
Accountability ★ Integrity ★ Reliability

GAO-04-248

GAO
Accountability•Integrity•Reliability

Highlights

Highlights of GAO-04-248, a report to congressional committees

March 2004

DEFENSE ACQUISITIONS

Assessments of Major Weapon Programs

Why GAO Did This Study

Although the weapons that the Department of Defense (DOD) develops have no rival in superiority, there still remain ways in which they can be improved. GAO's reviews over the past 20 years have found consistent problems with weapon acquisitions—cost increases, schedule delays, and performance shortfalls—along with underlying causes, such as pressure on managers to promise more than they can deliver. DOD can resolve these problems by using a knowledge-based approach derived from the best practices of successful product developments.

GAO's goal for this report is to provide congressional and DOD decision makers with an independent, knowledge-based assessment of selected defense programs that identifies potential risks and offers an opportunity for action when a program's projected attainment of knowledge diverges from the best practice. It can also highlight those programs that employ practices worthy of emulation by other programs. GAO plans to update and issue this report annually.

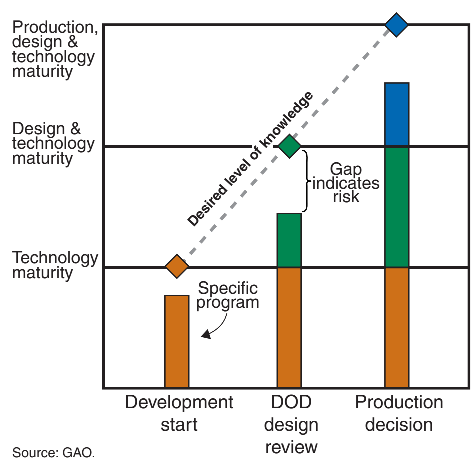
www.gao.gov/cgi-bin/getrpt?GAO-04-248.

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

What GAO Found

GAO assessed 51 defense programs ranging from the Missile Defense Agency's Airborne Laser to the Army's Warfighter Information Network. GAO's assessments are anchored in a knowledge-based approach to product development that reflects best practices of successful programs. This approach centers on attaining high levels of knowledge in three elements of a new product or weapon—technology, design, and production. If a program is not attaining this level of knowledge, it incurs increased risk of technical problems, with potential cost and schedule growth (see figure). If a program is falling short in one element, like technology maturity, it is harder to attain knowledge in succeeding elements.

Attainment of Product Knowledge



Source: GAO.

Most of the programs GAO assessed proceeded with less knowledge at critical junctures than suggested by best practices, although several came close to meeting best practice standards. GAO also found that programs generally did not track statistical process control data, a key indicator for production maturity. Program stakeholders can use these assessments to recognize the gaps in knowledge early and to take advantage of opportunities for constructive intervention—such as adjustments to schedule, trade-offs in requirements, and additional funding.

GAO has summarized the results of its assessments in a 2-page format. Each 2-page assessment contains a profile of the product that includes a description; a timeline of development; a baseline comparison of cost, schedule, and quantity changes to the program; and a graphical and narrative depiction of how the product development knowledge of an individual program compared to best practices. Each program office submitted comments and they are included with each individual assessment as appropriate.

Contents

Appendixes

Related GAO Products

Figures

Abbreviations

ACTS	AEHF Comsec/Transec System
AEA	Airborne Electronic Attack
DOD	Department of Defense
EKV	exoatmospheric kill vehicle
GAO	General Accounting Office
GEO	geosynchronous
GPS	global positioning system
HEO	highly elliptical orbit
HLV	heavy lift vehicle
IMIS	Integrated Maintenance Information System
ISO	International Organization for Standardization
KSDI	Key System Development Integration
MDA	Missile Defense Agency
MEADS	Medium Extended Air Defense System
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Association
SAR	synthetic aperture radar
SDACS	Solid Divert Attitude Control System
SDD	system development and demonstration
TBD	to be determined
TF/TA	Terrain Following and Terrain Avoidance
USAF	United States Air Force
USMC	United States Marine Corps
USN	United States Navy

GAO
Accountability * Integrity * Reliability

Comptroller General
of the United States

United States General Accounting Office
Washington, D.C. 20548

March 31, 2004

Congressional Committees

The Department of Defense (DOD) is in the midst of a modernization and transformation effort that will drive its spending priorities well into the next decade. DOD is investing heavily in programs that it believes will provide a new portfolio of military capabilities to decisively combat the full spectrum of threats to U.S. security. Investment in the research, development, and procurement of major weapon systems is expected to grow considerably as these efforts progress, rising from $135 billion in fiscal year 2004 to a projected $166 billion in 2009. DOD's total investment will, in fact, approach almost $1 trillion during the same period. These efforts to transform and modernize major weapon systems will not achieve their full potential if they are stymied by the cost growth and schedule delays that have limited the buying power of the defense investment dollar in the past.

For this reason alone, DOD needs to seek better outcomes from its new investments. It is also possible that these outcomes could have a significant affect on yet more urgent challenges to be faced by the federal budget in the forthcoming years. Health-care costs are growing at double-digit rates, and spending on homeland security will likely grow as the United States seeks to defeat terrorism worldwide. This country also faces an oncoming demographic tidal wave—by 2035, the number of people who are 65 or over will have doubled. These and other factors will substantially increase the demand on funding for associated entitlement programs, as well as create further pressures on discretionary funding—such as investments in weapon systems. Therefore, it is critical that DOD get the most out of these investments for the amounts budgeted. We believe that this report can provide useful insights on key risks in weapons development, allow decision makers to take corrective actions, and place needed and justifiable programs in a better position to succeed.

David M. Walker
Comptroller General
of the United States

GAO
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, D.C. 20548

March 31, 2004

Congressional Committees

The Department of Defense (DOD) develops weaponry that is unmatched in levels of technological sophistication and lethality. In an effort to transform the military, DOD is on the threshold of several major investments in improved weapon systems that are likely to dominate the budget and doctrinal debates well into the next decade. These programs include such systems as the Missile Defense Agency's suite of land, sea, air, and space defense systems; the Army's Future Combat Systems; the Air Force's, Marine Corps', and Navy's Joint Strike Fighter; and overarching systems, such as the Advanced Wideband Satellite/Transformational Satellite.

Despite their superiority, these weapon systems will routinely take much longer to field, cost more to buy, and require more support than provided for in investment plans. An alternative approach must be found to develop these systems. Our work on best practices has found that programs managed within a knowledge-based approach—where high levels of product knowledge are demonstrated at critical points during development—are better positioned to deliver superior performance within cost and schedule estimates. We believe that by employing this approach, DOD can get similar outcomes from its weapon system programs.

This annual report is one step in our effort to help DOD adopt a more knowledge-based approach. In this current report, we assess 51 major weapon systems whose combined program costs exceed $672 billion. Each assessment is presented in a 2-page summary that analyzes each program's attainment of knowledge as compared with best practices, along with its cost and schedule status. Our objective is to provide decision makers with an independent, knowledge-based assessment of individual systems that identifies potential risks and allows decision makers to take early actions, if warranted, to put programs in a better position to succeed.

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 different, more cross-cutting perspective—one that draws lessons learned from best system development practices to see if they apply to weapon system development. We found that successful product developers employed specific practices to ensure that a high level of knowledge regarding critical facets of the product was achieved at key junctures in development. We characterized these junctures as three knowledge points. We also identified key indicators that can be used to assess the attainment of knowledge. When tied to major events on a program's schedule, they can disclose whether gaps or shortfalls exist in demonstrated knowledge, which can presage future cost, schedule, and performance problems. These knowledge points and associated indicators are defined as follows.

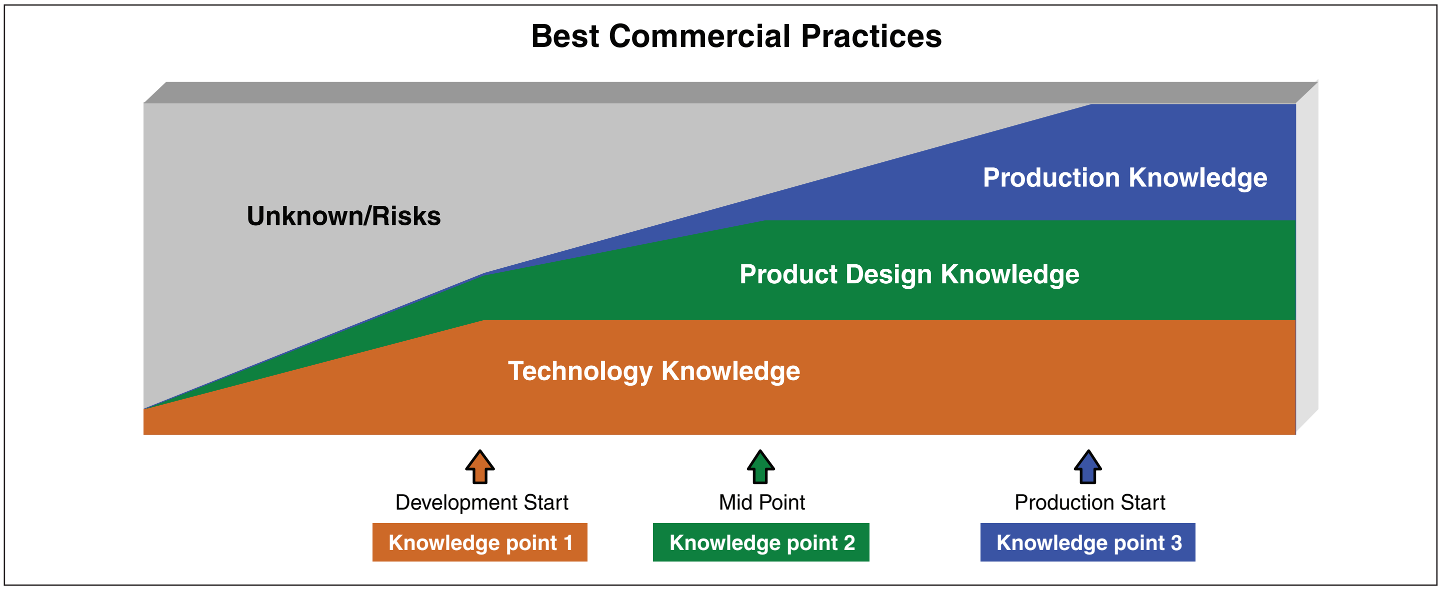
Knowledge point 1: Resources and needs are matched. This level of knowledge is attained when a match is made between a customer's needs and the developer's technical, financial, and other resources. Achieving a high level of technology maturity at the start of system development is a particularly important best practice. This means that the technologies needed to meet essential product requirements have been demonstrated to work in their intended environment.

Knowledge point 2: The product design is stable. This level of knowledge is attained when the product's design is shown to meet the customer's requirements. A best practice is to achieve design stability at the system-level critical design review, usually held midway through development. Completion of engineering drawings at the system design review provides tangible evidence that the design is stable.

Knowledge point 3: Production processes are mature. This level of knowledge is attained when it is demonstrated that the product can be manufactured within cost, schedule, and quality targets. A best practice is to achieve production maturity at the start of production. This means that all key manufacturing processes produce output within statistically acceptable limits for quality.

As illustrated in figure 1, the attainment of each successive knowledge point builds on the preceding one. While the knowledge itself builds continuously without clear lines of demarcation, the attainment of knowledge points is sequential. In other words, production maturity cannot be attained if the design is not mature, and design maturity cannot be attained if the key technologies are not mature.

Figure 1: Building Knowledge at Key Points in Product Development Reduces the Risk of Unknowns



Source: GAO.

For the most part, all three knowledge points are eventually attained on a completed product. The difference between highly successful product developments—those that deliver superior products within cost and schedule projections—and problematic product developments is how this knowledge is built and how early in the development cycle each knowledge point is attained. If a program is attaining the desired levels of knowledge, it has less risk—but 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.

Knowledge-Based Assessments

Our assessment of each program is summarized in two components—(1) a system profile and (2) a product knowledge assessment.

The system profile presents a general description of the product in development; a picture of the product or of one of its key elements; a schedule timeline identifying key dates in the program; a table identifying the prime contractor, the program office location, and the funding remaining from fiscal 2004 through completion, if available; and a table summarizing the cost, schedule, and quantity changes to the program.

The rest of the assessment analyzes the extent to which product knowledge at the three key knowledge points has been attained. We depict the extent of knowledge in a stacked bar graph and provide a narrative summary at the bottom of the first page. The second page is devoted to a narrative assessment of technology, design and production maturity, as well as other program issues identified and comments from the program office.

As shown is figure 2, the knowledge graph is based on the three knowledge points and the key indicators for the attainment of knowledge. A “best practice” line is drawn based on the ideal attainment of the three types of knowledge at the three knowledge points. As can be seen, knowledge about the technology, design, and production of a new product builds over time. The closer a program’s attained knowledge is to the best practice line, the more likely the weapon will be delivered within its estimated cost and schedule. A knowledge deficit at the start of development—indicated by a gap between the technology knowledge attained by the weapon system and the best practice line—means the program proceeded with immature technologies and may face a greater likelihood of cost and schedule increases as technology risks are discovered and resolved.

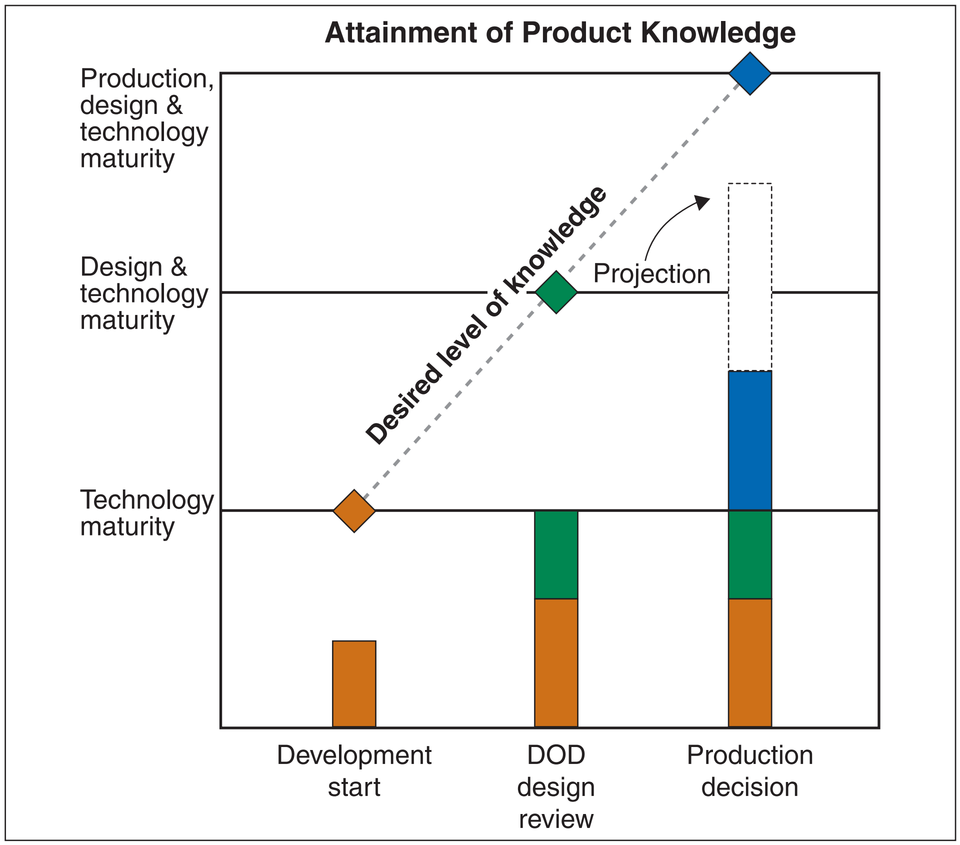
The first knowledge point on the best practice line represents two facts: a commitment to a new system development has been made and the key technologies needed for the new product are mature. The orange bar indicates the actual technology maturity attained for a program’s key technologies as measured at the start of development—normally milestone II or milestone B in DOD’s acquisition process.[1] The second major point on the best practice line captures technology maturity plus

[1] Technology maturity is attained when a technology demonstrates that it works in an operational environment. See appendix III for definitions of technology readiness levels.

design maturity. A green bar indicates the design knowledge attained by a weapon system program. A design is considered mature when 90 percent of the engineering drawings have been released or deemed releasable to manufacturing. The third major point on the best practice line captures the sum of technology maturity, design maturity, and production maturity. A blue bar indicates the production knowledge attained by a weapon system program. Production is considered mature when all key production processes are in statistical control.[2] The blue bar is stacked on top of the orange and green bars to indicate whether any cumulative technology, design, and production gaps exist at the time production begins. In some cases, we obtained projections from the program office of future knowledge attainment. These projections are depicted as dashed bars.

[2] 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. (See app. II for further information.)

Figure 2: Depiction of a Notional Weapon System Program'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 found two situations in which programs were unable to provide key knowledge indicators. We used two types of labels in the knowledge graphs to depict those situations. Programs with these labels are distinguished from those that have elected not to collect data that can be used to assess progress against best practices. First, some programs were unable to reconstruct the relevant knowledge indicator because the event happened too many years ago. In these situations, we annotate the graph with the phrase “Data not available.” Second, a few programs have not followed the traditional acquisition model. For example, some programs combined the development start decision with the production decision. Other programs used commercial off-the-shelf components, which negated the need to monitor production processes. In these situations, we annotate the graph with the phrase “Not applicable.”

We conducted our review from June 2003 through March 2004 in accordance with generally accepted government auditing standards. Appendix II contains detailed information on our methodology.

General Observations

Most of the programs we assessed proceeded with lower levels of knowledge at critical junctures and attained key elements of product knowledge later in development. In addition, while most programs were able to assess technology maturity using technology readiness levels and were able to track the status of engineering drawings, few programs collected or analyzed information on production process controls. We did find some programs that attained relatively high levels of key product knowledge. Examples of programs that demonstrated relatively high levels of technology, design, and production maturity are provided below, along with examples of programs where levels of product knowledge were low. While DOD has announced the cancellation of the Comanche program to reallocate resources, the program still demonstrated relatively high levels of design and production knowledge. The examples below include Comanche because it remains a good example of attaining key product knowledge.

Technology Maturity

The following programs attained a greater level of technology maturity before entering system development than most weapon systems we assessed:

- The B-2 Radar Modernization program demonstrated full technology maturity in advance of the start of system development. A formal technology readiness assessment is planned for completion prior to the start of development in May 2004. The program has already built and tested some transmit/receive modules, and several key elements of the modules were already tested in an operational environment.

- The MQ-9 Predator B aircraft program has matured three of the program's four technologies, and the fourth—an avionics subsystem designed to integrate and store data necessary to launch munitions—is comprised of several off-the-shelf components and is being evaluated in a laboratory environment.

In some programs, the consequences of proceeding with immature technologies have already been felt. For example:

- The Extended Range Guided Munition program began system development in 1996 with only 1 of its 20 critical technologies mature. While progress has been made, full technology maturity was still not demonstrated at the time of the design review in 2003. The lack of mature technologies contributed to cost increases, schedule delays, and test failures. These test failures later led the program to miss a Navy deadline that required successful completion of two land-based flight tests by November 2003. The Navy is conducting an independent assessment of the program's readiness to proceed with further flight-testing. The Navy has also issued a solicitation for alternative precision-guided munition concepts that could offer cost savings.

- The Advanced SEAL Delivery System began system development over 9 years ago, and currently has technologies that are not fully mature. During that time, total program costs increased 571 percent. While progress has been made within the past year, the technologies are not expected to reach maturity until the second boat is built in 2008.

- The Advanced Wideband Satellite/Transformational Satellite program has only matured one of its five critical technologies, with the remaining four scheduled to reach maturity in early 2006. This is more than 2 years after the planned start of development. While the program's acquisition strategy allows for concurrent technology and system development, concern over this aggressive acquisition strategy led the Air Force to schedule an interim review for November 2004. This review will determine whether the program's technology development has progressed sufficiently or whether alternative action should be taken. To date, program costs have increased 148 percent.

Design Maturity

In a number of these programs, having mature technology at the start of system development resulted in having more design stability at the time of the design review. Some examples include:

- The Theater High Altitude Area Defense System program attained full technology and design maturity in advance of the design review in December 2003. This program made significant strides following a problematic preliminary development phase where the delayed demonstration of technologies and components, and reliance on full-system testing to discover problems, nearly caused the cancellation of the program. The program has since structured a system development phase with a much greater emphasis on risk reduction, including the use of technology readiness levels. The program achieved design stability by releasing 100 percent of engineering drawings before the design review.

- The National Polar-Orbiting Operational Environmental Satellite System achieved 86 percent technology maturity before committing to system development, and the program has completed half of the currently identified drawings well in advance of the design review in April 2006. The program is also taking steps to reduce program risk by demonstrating three critical sensors on a demonstrator satellite prior to their inclusion on the new satellite.

- The Comanche Reconnaissance Attack Helicopter program released 84 percent of design drawings by the time of its design review. Additionally, the tools used to gather and validate knowledge on the Comanche's design were required by contract, with targeted award fees that provided additional incentives for building knowledge.

Other programs proceeded with their design review without having the requisite level of technology knowledge. This lack of knowledge affected the level of design stability attained. For example:

- The F/A-22 Fighter program began system development in 1991 without having mature technologies—deferring knowledge point 1—and subsequently attained only a quarter of the desired amount of engineering drawings at the time of the design review in 1995. While the program now has mature technology and design stability, the program experienced substantial cost increases and schedule delays in the latter stages of development.

- The Guided Missile System Air Defense (Patriot) PAC-3 program attained less technology maturity and design maturity than best practices suggest. At the time of the design review in 1996, the program only had 23 percent design maturity, and the technologies were still not mature. The seeker technology did not demonstrate maturity until close to the production decision. The cost of the seeker increased by 76 percent and contributed to a 2-year delay in the program's schedule.

- The Advanced Threat Infrared Countermeasure/Common Missile Warning System held its design review in 1997 with only 22 percent design maturity. While the basic design of the system is now complete, it was not until 2 years after the design review that 90 percent of the drawings were released and the design was considered stable. This resulted in inefficient manufacturing, rework, additional testing, and a 3-year schedule delay.

Production Maturity

Unlike technology readiness levels, which can be applied at any time, and engineering drawing release data, which is captured on all programs, few programs collected statistical process control data. While the absence of this data does not necessarily mean that production processes were immature, it does prevent an assessment against an objective standard. Other indicators of production maturity, such as scrap and rework rates, can indicate positive trends, but are not prospective—that is, they are not useful in guiding preparations for production. To some extent, statistical process control data is not collected because DOD is delegating more responsibility to prime contractors and reducing the amount of data requested. The lack of such data may put program offices in a disadvantaged position to gain insights about a contractor's production progress. Some programs, however, have started changing this trend, making the collection of statistical process control data part of the contract requirements. For example:

- The Comanche Reconnaissance Attach Helicopter program called for collecting more knowledge about production processes and maturity than we have seen on many programs. Specifically, the Army planned to collect information on control over the production processes and reliability and included these requirements in the Comanche contract. In addition, the contractor had established reliability growth plans and goals and had started conducting reliability growth testing.

- The Tactical Tomahawk missile program has begun collecting statistical control data from the assembly of components for the first low-rate production cycle. Initial data in support of verifying critical process compliance is expected in March 2004. Program officials plan to establish preliminary boundaries for upper and lower control limits by the full-rate production decision in June 2004, and metrics are expected to be fully stable by the completion of the low-rate deliveries in November 2004.

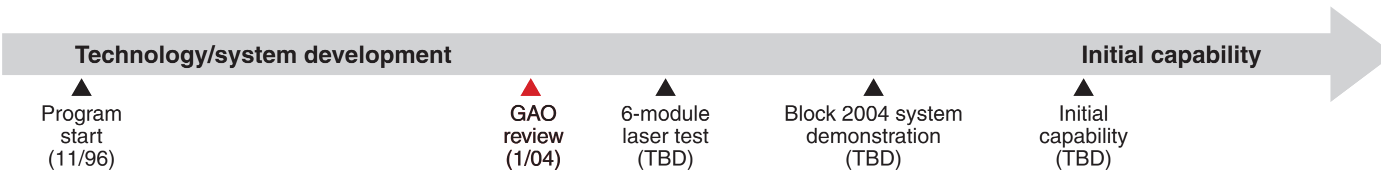
Assessments of Individual Programs

Our assessments of the 51 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 skin of enemy missiles; and a battle management subsystem to plan and execute engagements. We assessed the Block 2006 configuration. Program officials expect this block to provide an initial capability, but not before 2006.

Source: Airborne Laser Program Office.



Program Essentials

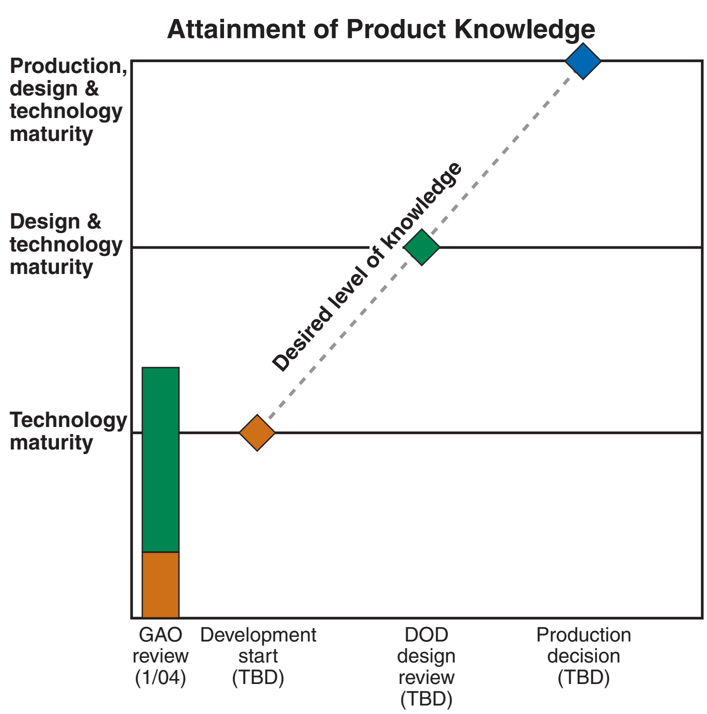
Prime contractor: Boeing
Program office: Arlington, Va.
Funding to complete through 2009:
- R&D: $3,274.3 million
- Procurement: $0.0 million
- Total funding: $3,274.3 million
- Procurement quantity: 0

Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 09/2003	Percent change
Research and development cost	NA	$5,471.1	0.0
Procurement cost	NA	$0.0	0.0
Total program cost	NA	$5,471.1	0.0
Program unit cost	**NA**	**$5,471.130**	**0.0**
Total quantities	NA	1	0.0
Acquisition cycle time (months)	NA	TBD	TBD

Latest cost includes all costs from the program's inception through fiscal year 2009. Procurement funding and quantities have yet to be determined. NA = not applicable

Only one of ABL's seven critical technologies is fully mature, yet MDA has released about 93 percent of the current block's engineering drawings. Program officials plan to use the first ABL block to demonstrate these technologies, but until this occurs, the potential for design change remains. Additional drawings may also be needed if the design is enhanced during the next block. The program experienced a $242-million cost increase during fiscal year 2003, mainly because of difficulties manufacturing components that could meet requirements. Program officials recently postponed the procurement of the second aircraft because of testing delays. This postponement allowed them to shift funds to cover fiscal year 2003 cost overruns associated with efforts to build the first aircraft.



ABL Program

Technology Maturity

Only one of ABL's seven critical technologies—managing the high power beam—is fully mature. The remaining six other technologies—the six-module laser, missile tracking, atmospheric compensation, transmissive optics, optical coatings, and jitter control—are not fully mature. The last three technologies are the least mature. All the above technologies are necessary for generating and directing laser energy onto a boosting missile.

While the program office has assessed the six-module laser as being close to reaching full maturity, the power generated by grouping six laser modules together must be demonstrated before this assessment can be validated. The transmissive optics, optical coatings, and jitter control are the least mature and consist of prototype technologies that have only been tested in the laboratory, or demonstrated through analysis and simulation. They have not been tested during the operation of the six-module laser. The program plans to prove that all technologies will work in an operational environment during a flight test when ABL will attempt to shoot down a short-range ballistic missile. Because the program cannot replicate an operational environment on the ground, this flight test will provide the first opportunity for many technologies to demonstrate their maturity.

Design Maturity

The ABL program has completed 93 percent, or over 9,900, of the expected 10,631 engineering drawings for the first block. Although releasing this percentage of drawings suggests that ABL's design is stable, it is a measurement of the current block's design stability rather than the stability of future ABL blocks. Technology maturation and future enhancements may lead to more design changes.

Production Maturity

We did not assess the production maturity of ABL's current block because of the limited quantity of hardware being produced. Accordingly, statistical process control data is not available. Program officials explained that it has been difficult to maintain a stable manufacturing base for some subcomponents and that this problem has not been resolved.

Other Program Issues

Program officials recently identified performance of the ABL system being developed during the current block as one of their greatest risks toward achieving an initial capability. Between October 2002 and September 2003, development costs increased by about $242 million. Program officials attributed the cost overruns to difficulties with component manufacturing and integration. They noted, for example, that the leading cause of cost growth in the current effort is the difficulty in manufacturing advanced optics and laser components.

Planned testing of the six integrated laser modules continues to slip, and as of early February, the program had not rescheduled the test. Program officials attribute the delays to the complexity and volume of integration activities. This delay could affect subsequent program events and has already caused the program to postpone procurement of a second aircraft. The delay allowed program officials to shift those funds, along with funds intended for other program activities, to cover fiscal year 2003 cost overruns associated with efforts to build the first aircraft.

Program Office Comments

In commenting on a draft of this assessment, MDA maintained that the current design is stable despite the assessed technology maturity. Officials told us that because the ABL operational environment is impractical to duplicate on the ground, the technology maturity assessment process will understate actual maturity until after 100 percent of the drawings are released. While the officials expect changes to future blocks as part of spiral development, they believe the basic design will directly migrate to subsequent blocks.

With respect to the timing of the purchase of the second aircraft, officials said the decision is still under deliberation as MDA constantly assesses progress toward all objectives, including technical maturity.

Aegis Ballistic Missile Defense (Aegis BMD)

MDA's Aegis BMD element of missile defense is being developed in incremental, capability-based blocks to protect deployed U.S. forces and other assets from ballistic missiles. Its two missions are long-range surveillance and tracking in support of the Ballistic Missile Defense System and engagement of short- and medium-range ballistic missiles using the Standard Missile-3 (SM-3). We assessed the maturity of the Block 2004 SM-3 missile.

Source: U.S. Navy.

Program Essentials

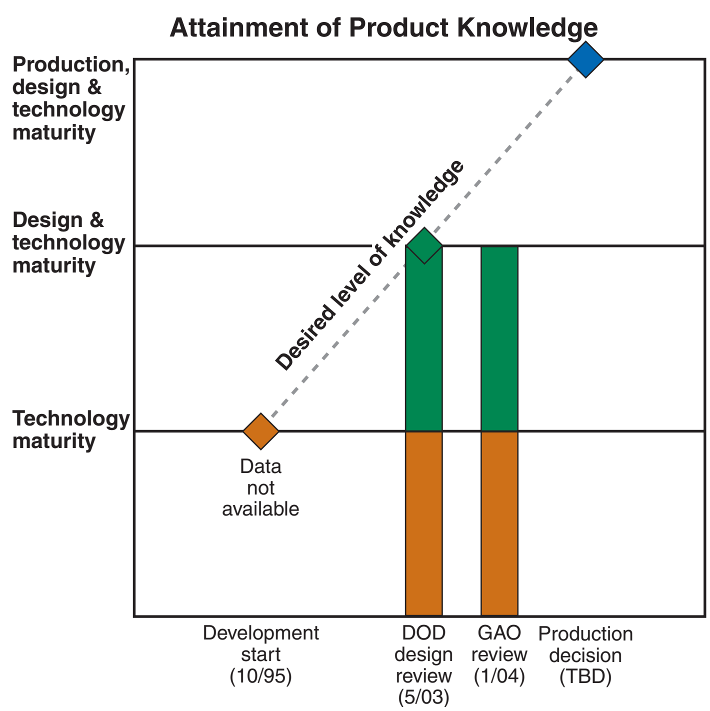
Prime contractor: Lockheed Martin/Raytheon
Program office: Crystal City, Va.
Funding to complete through 2009:
R&D: $3,918.1 million
Procurement: $0.0 million
Total funding: $3,918.1 million
Procurement quantity: 0

Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 11/2003	Percent change
Research and development cost	NA	$6,981.1	0.0
Procurement cost	NA	$0.0	0.0
Total program cost	NA	$6,981.1	0.0
Program unit cost	**NA**	**$0.000**	**0.0**
Total quantities	NA	0	0.0
Acquisition cycle time (months)	NA	TBD	TBD

Latest cost includes all costs from the program's inception through fiscal year 2009. Procurement funding and quantities have yet to be determined. NA = not applicable

According to the program office, the SM-3 technologies are mature and the design is stable. However, the technology that enables the interceptor's kill vehicle to maneuver itself to hit and destroy its target has not been fully demonstrated. This "divert" technology succeeded in ground testing but failed during a flight test in June 2003. MDA expects Aegis BMD to perform long-range surveillance and tracking in support of the Ground-based Midcourse Defense element beginning in September 2004. Agency plans call for Aegis BMD to be capable of engaging short- and medium-range ballistic missiles by December 2005.



AEGIS BMD Program

Aegis BMD Element-Block 2004

SM-3 development began with the "ALI" Program, a series of intercept flight tests to demonstrate critical technologies of an interceptor launched from a Navy cruiser. The SM-3 interceptor builds upon the SM-2 missile, a two-stage missile in operational use by the U.S. Navy, but incorporates a third stage rocket motor and a kinetic warhead—the kill vehicle.

The third stage rocket motor and the infrared seeker of the kill vehicle have been demonstrated in previous flight tests. However, while the new solid divert attitude control system (SDACS) passed a series of ground tests, it failed during its first flight test in June 2003. According to program documents, the most likely cause of the failure was a defective component within SDACS. The Aegis BMD Program Office expects to resolve the issue by early 2004.

Design Maturity

The SM-3 missile design is stable. At the time of the critical design review in May 2003, 98 percent of the total expected drawings were releasable to the manufacturer.

Production Maturity

To meet a presidential directive requiring the fielding of an initial missile defense capability beginning in 2004, five SM-3 missiles are being developed in fiscal year 2004. These missiles are accelerated test assets that could also be used, if needed, in a national emergency. However, the missiles will not have a fully functional SDACS. We did not assess statistical control processes for the five missiles because these missiles are not production representative.

Other Program Issues

Another component of the Aegis BMD program involves an upgrade of the Aegis Weapon System—an operational asset comprised of the AN/SPY-1 Radar and Weapon Control System software—to accommodate the BMD mission. Program officials told us that development and delivery of the Aegis Weapon System are proceeding on schedule.

Program Office Comments

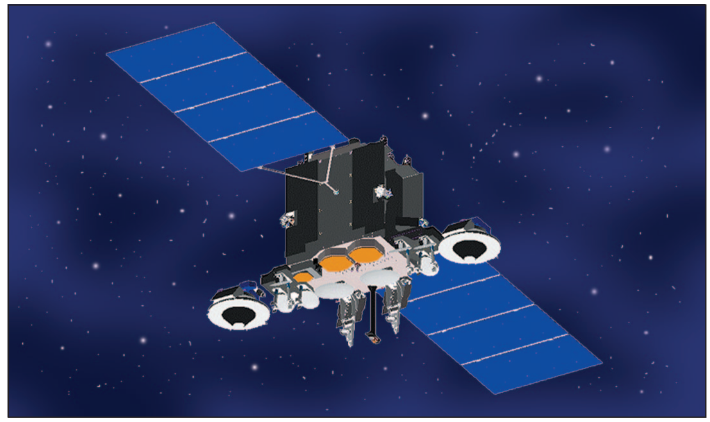
In commenting on a draft of this assessment, the program office generally concurred with the information presented. It added that the latest flight test, held in December 2003, provided a successful demonstration of SDACS.

GAO Comments

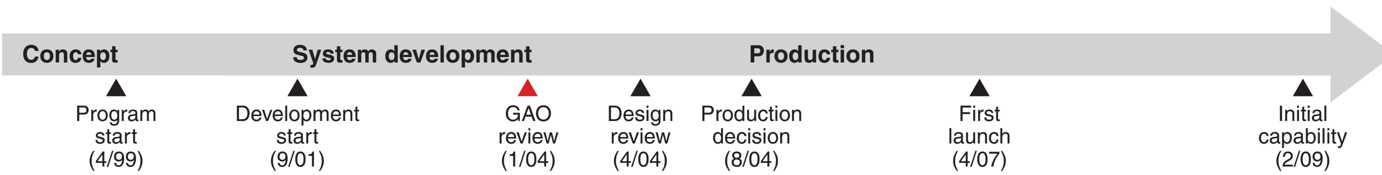
While the program did conduct an SDACS test in December, this test did not fully address SDACS issues because the divert system operated in sustain mode. In sustain mode, the system does not use its two pulse motors to steer the warhead during the final minutes before reaching the target. To be considered fully functional, SDACS will require successful testing using the two pulse motors.

Advanced Extremely High Frequency Satellite (AEHF)

The Air Force's AEHF satellite system is intended to replenish the existing Milstar system with higher capacity, survivable, jam-resistant, worldwide, secure communication capabilities for strategic and tactical warfighters. The system also includes 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. First launch is scheduled for December 2006.



Source: AEHF Program Office.



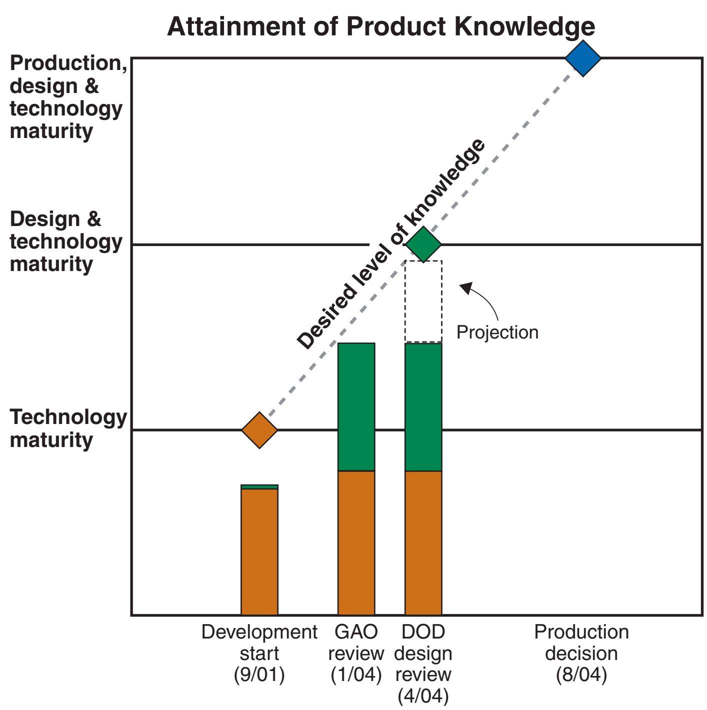
Program Essentials

Prime contractor: Lockheed Martin
Program office: El Segundo, Calif.
Funding needed to complete:
- R&D: $2,452.0 million
- Procurement: $473.6 million
- Total funding: $2,925.6 million
- Procurement quantity: 1

Program Performance (fiscal year 2004 dollars in millions)

	As of 10/2001	Latest 09/2003	Percent change
Research and development cost	$4,168.4	$4,356.1	4.5
Procurement cost	$1,232.9	$473.6	-61.6
Total program cost	$5,401.3	$4,829.8	-10.6
Program unit cost	**$1,080.254**	**$1,609.917**	**49.0**
Total quantities	5	3	-40.0
Acquisition cycle time (months)	111	118	6.3

The AEHF satellite program demonstrated most of its critical technologies at development start and expects to have all technologies demonstrated by the design review. The program has released two-thirds of its drawings and expects to complete 90 percent by the design review. In September 2003, the program office decided to delay the launch of the first two satellites by 4 months. The delay was necessary to accommodate changing security requirements and resolve fabrication issues relating to the critical cryptological equipment.



AEHF Program

Technology Maturity

Eleven of the critical technologies identified by the program office are mature. The remaining three technologies have engineering models and are undergoing testing in a relevant environment to simulate both launch and space atmosphere. Two of these three technologies have mature backup technologies. Only one technology, a component of the phased array antenna, does not have a backup technology that meets operational requirements. Program officials expect all technologies to be mature by the design review scheduled for April 2004.

Design Maturity

The program office has released over two-thirds of its expected drawings. The program office expects to release 90 percent of the expected drawings by the scheduled design review. In addition, preliminary design reviews are complete and the program office has initiated the subsystem design reviews. The program is also developing early software builds for the ground and space segments.

Production Maturity

The production maturity could not be assessed because the program office does not have statistical process control data. The Air Force currently plans to buy only three satellites. However, there have been some problems in producing a critical system component. The AEHF Comsec/Transec System (ACTS) is a suite of cryptological equipment installed in both the satellites and the terminals to limit access to authorized users. ACTS has already experienced significant cost growth and schedule delays due to changes in satellite architecture design, interface, and other requirements changes. ACTS consists of computer chips whose fabrication is more technically challenging than producing other computer chips. The challenge results from a security requirement to have separate foundries produce components of the chips that must be integrated together. During a major functional test in September 2003, a problem was discovered, and the program is evaluating ways to resolve the problem.

Concurrent development of ACTS and the AEHF satellite payload has resulted in a 4-month delay in the launch of the first two AEHF satellites, now scheduled for April 2007 and April 2008, respectively. ACTS is managed by the National Security Agency and is on the AEHF satellite payload critical path. The program office stated the launch delay was necessary to accommodate changes in ACTS security requirements and resolve ACTS production issues.

Other Program Issues

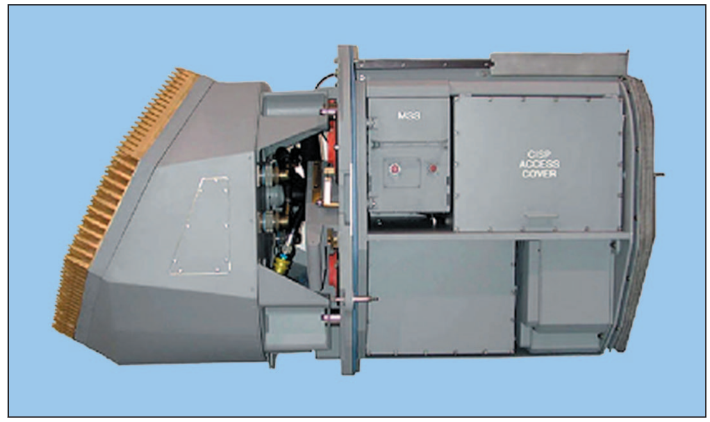
The current development contract includes the first two satellites and the mission control segment. A decision to buy a third satellite is planned after the design review. In December 2002, two satellites were deleted from the program because the newly developed Transformational Communications Architecture calls for the Transformational Satellite, assessed elsewhere in this report, to replace these AEHF satellites. Because the Transformational Satellites are early in development and may not progress in time to meet the military need, the Air Force has scheduled a progress review and decision point in early fiscal year 2005 to determine if additional AEHF satellites will be needed to meet operational requirements.

Program Office Comments

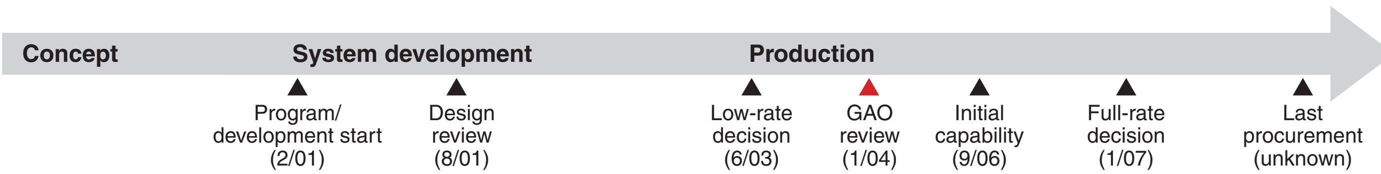
In commenting on a draft of this assessment, the program office noted that the AEHF program continues to progress through the system development and demonstration phase, meeting all scheduled milestones and is projected to meet all key performance parameters.

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 the existing aircraft.



Source: U.S. Navy.



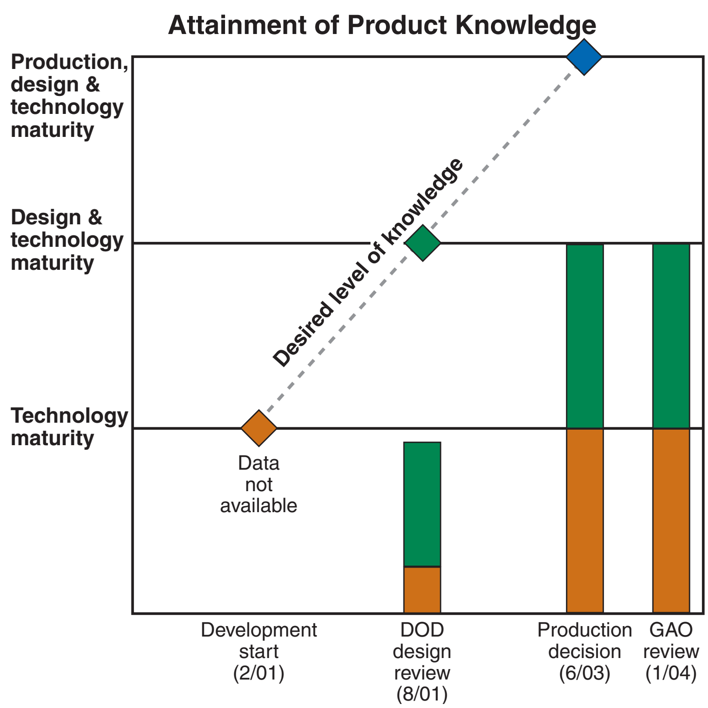
Program Essentials

Prime contractor: McDonnell Douglas, Corp.
Program office: Patuxent River, Md.
Funding needed to complete:
- R&D: $219.9 million
- Procurement: TBD
- Total funding: TBD
- Procurement quantity: TBD

Program Performance (fiscal year 2004 dollars in millions)

	As of 06/2001	Latest 09/2003	Percent change
Research and development cost	$520.0	$547.7	5.3
Procurement cost	$0.0	$0.0	0.0
Total program cost	$520.0	$547.7	5.3
Program unit cost	**$0.000**	**$1.320**	**0.0**
Total quantities	0	415	0.0
Acquisition cycle time (months)	69	67	-2.9

The AESA radar's technology appears mature and the design is stable. The program entered system development with technologies leveraged from other DOD programs. However, the program identified four critical technologies new to radar application. These technologies were not mature at the start of system development or at the design review, but they are now mature. Design changes have been identified as a result of completed development tests, and more changes are anticipated as development and operational tests continue during production. The program anticipates retrofitting 135 aircraft with the radar at a cost of about $424 million. These numbers could increase if operational evaluation is delayed. Program officials estimate that the AESA radar's first low-rate production units will exceed the cost target by 27 percent. Cost reduction initiatives are underway.



AESA Program

Technology Maturity

The AESA radar program utilizes technologies from other DOD programs. Four critical technologies are new to radar application. These technologies were evaluated using technology readiness levels and determined to be mature based on initial testing. Software maturity must be increased before this radar can be fully tested.

Design Maturity

The AESA radar's design is stable. The program had 67 percent of drawings released at design review. Additional drawings, however, may be needed to address engineering design changes evolving out of ongoing development tests and to address immature hardware and software that existed during recently completed development tests. Software development, to support development tests and technical evaluation, is planned through most of fiscal year 2004. Operational evaluation, to determine radar effectiveness and suitability, will be completed in the summer of 2006. A recent initial operational test identified a number of risks that will need to be addressed through development tests before operational evaluation of the radar.

The program is tracking a number of technical, cost, and schedule risks and challenges. First, the AESA radar places excessive loads on the environmental control system. Second, parallel F/A-18E/F development efforts may affect AESA integration and tests and delay production and delivery schedules. Third, AESA radar operations could degrade performance of other subsystems, resulting in unacceptable weapon system performance.

Production Maturity

We could not assess production maturity because statistical control data was not available.

Other Program Issues

The AESA radar's first low-rate production units are expected to exceed the cost target by 27 percent. Most of the cost increase is attributable to subcontractor development cost. The increase will not affect the three favorably negotiated low-rate production lot options. Cost increases during full-rate production, however, will occur if cost reduction initiatives are not pursued. Cost reduction initiatives are underway to reduce the cost overruns once the fix priced options expire, but the initiatives are not fully funded. A recent cost estimate, however, projects the program to be fully funded throughout the 5-year defense plan.

Delivery of the first production AESA radars, for insertion into F/A-18E/F aircraft on the production line, is scheduled for fiscal year 2005. This will result in only 8 of the planned 45 F/A-18E/F aircraft in that fiscal year being equipped with the AESA radar on the production line. A match between AESA radar production and F/A-18E/F production will occur, with deliveries in fiscal year 2008. As a result of the mismatch, 135 of the radars will need to be retrofitted into already produced aircraft at a projected cost of $424 million. This cost does not include the cost of legacy radars that must be installed on aircraft that are not receiving the AESA radar. The need to retrofit could be reduced if more radars were made available sooner. However, while excess radar production capacity exists, program management does not want to ramp up this production beyond current plans because it would add risk to the program and take the radar into production prior to completion of operational evaluation in mid fiscal year 2006. Delay of operational evaluation would result in greater retrofit numbers.

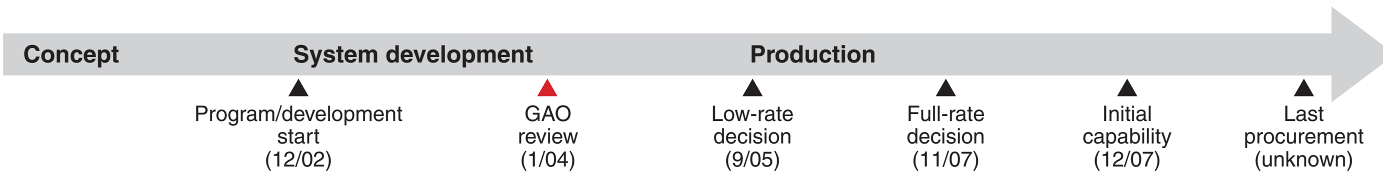
Program Office Comments

The AESA program office concurred with this assessment and provided clarifying comments. The AESA radar received approval for the second low-rate initial production effort from the Assistant Secretary of the Navy, Research Development and Acquisition in January 2004. The first F/A-18F with the AESA radar installed recently demonstrated high resolution synthetic aperture radar (SAR) modes at 3 times the resolution and 2-1/2 times the range of the current operationally deployed F/A-18 radar. This high resolution SAR mode capability represents the first step in multiple areas that the AESA radar will greatly improve the F/A-18E/F Super Hornet's air-to-air and air-to-ground radar capabilities in addition to adding modes not currently available to the fleet.

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 will 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: © 2003 General Dynamics Armament and Technical Products, All Rights Reserved.



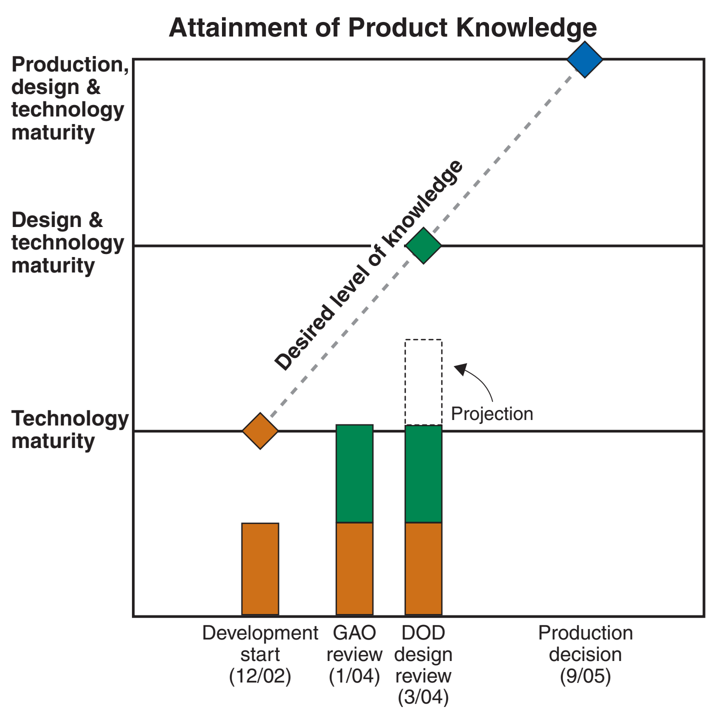
Program Essentials

Prime contractor: General Dynamics
Program office: Huntsville, Ala.
Funding needed to complete:
- R&D: $93.5 million
- Procurement: $1,530.0 million
- Total funding: $1,777.4 million
- Procurement quantity: 89,420

Program Performance (fiscal year 2004 dollars in millions)

	As of 12/2002	Latest 10/2003	Percent change
Research and development cost	$116.1	$116.1	0.0
Procurement cost	$1,530.0	$1,530.0	0.0
Total program cost	$1,800.2	$1,800.2	0.0
Program unit cost	**$0.020**	**$0.020**	**0.0**
Total quantities	89,420	89,420	0.0
Acquisition cycle time (months)	59	59	0.0

The APKWS entered system development before demonstrating that its critical guidance technology was fully mature. Program officials currently project that the technology will not demonstrate maturity until after the system design review. The program has released about half of expected drawings, and program officials expect all will be released by the time of the design review in March 2004. If immature technology persists at the design review, risks of redesign and modification of drawings late in development will be incurred.



APKWS Program

Technology Maturity

The APKWS' critical laser guidance technology has not demonstrated full maturity. Although a prototype guidance system was successfully demonstrated under the Low Cost Precision Kill Advanced Technology Demonstration, the current design for the guidance system includes numerous hardware changes to improve system cost, performance, and producibility. The new design will not be fully integrated and tested until June 2004, 3 months after the design review. Program officials noted that although the prototype system design exists, reverting to that design would increase cost and degrade the system's performance and producibility.

Design Maturity

Program officials expect to release 100 percent of the drawings by the system-level design review in March 2004. At the time of our review, the program had released only 55, or about 48 percent, of the 115 total planned drawings to manufacturing.

Production Maturity

Program officials expect that there will be nine key processes associated with manufacturing the APKWS. The program plans to collect statistical data on these processes when production begins.

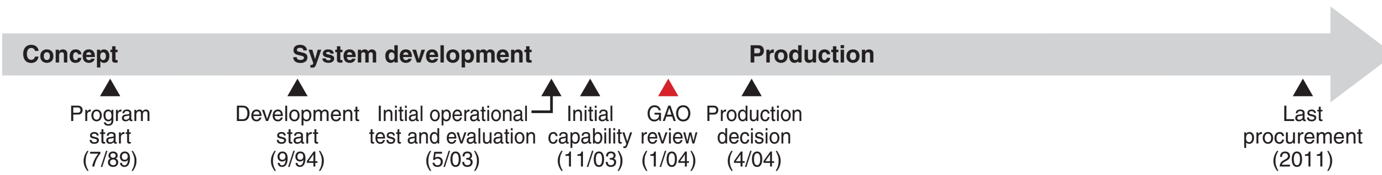
Program Office Comments

In commenting on a draft of this assessment, the program office stated that it demonstrated the technology maturity required by DOD acquisition system policy during the Low Cost Precision Kill Advanced Technology Demonstration. The APKWS technologies were successfully demonstrated in both a high fidelity hardware-in-the-loop test facility and a live-fire flight test environment. Program officials also stated that although the system's final design requires some modification to meet affordability, producibility, and operational requirements, these design changes are consistent with the intent of the system development and demonstration phase.

Advanced SEAL Delivery System (ASDS)

The Special Operations Forces' ASDS is a battery-powered, dry interior minisubmarine developed for clandestine insertion and extraction of Navy SEALs and their equipment. It is carried to its deployment area by a specially configured SSN-688 class submarine. ASDS is intended to provide increased range, payload, on-station loiter time, and endurance over current submersibles. The 65-foot long, 8-foot diameter ASDS is operated by a two-person crew, and equipped with a lock out/lock in chamber to allow divers to exit and reenter the vehicle.

Source: U.S. Navy.



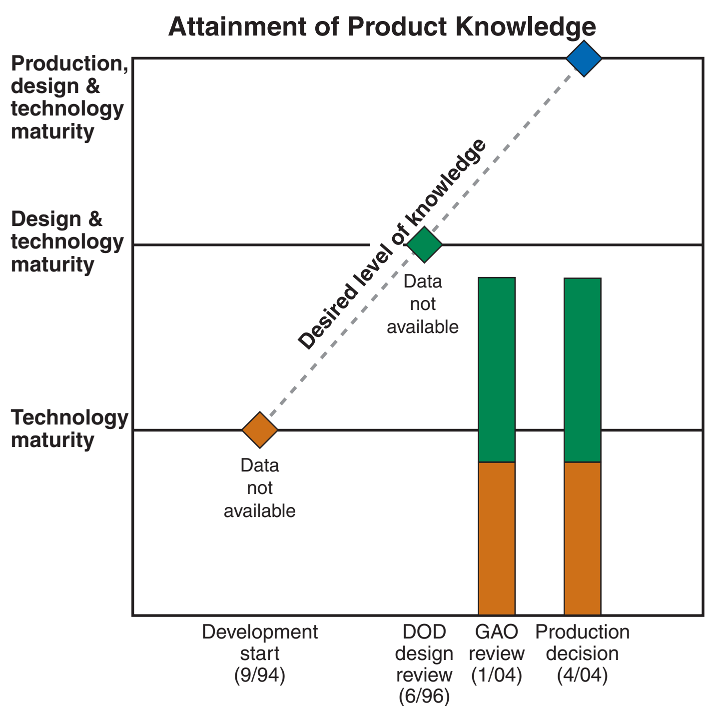
Program Essentials

Prime contractor: Northrop Grumman
Program office: Washington, D.C.
Funding needed to complete:
- R&D: $35.8 million
- Procurement: $1,268.0 million
- Total funding: $1,341.4 million
- Procurement quantity: 5

Program Performance (fiscal year 2004 dollars in millions)

	As of 09/1994	Latest 12/2003	Percent change
Research and development cost	$140.0	$457.5	226.9
Procurement cost	$124.1	$1,345.5	984.6
Total program cost	$278.1	$1,865.5	570.8
Program unit cost	**$92.699**	**$310.918**	**235.4**
Total quantities	3	6	100.0
Acquisition cycle time (months)	NA	NA	NA

Two of ASDS' three critical technologies, the battery and the propulsion, are not fully mature, even though system development began over 9 years ago. Key technical problems with the battery and the propeller were discovered late—during testing on the first boat—rather than in component- or subsystem-level testing. Although significant progress has been made in the past year, all critical technologies have not achieved maturity and will not reach maturity until the second ASDS boat is produced, currently estimated to be in 2008. However, program officials believe technology maturity may be reached as early as 2005. In April 2003, DOD designated ASDS as a major defense acquisition program, entailing greater oversight by high-level decision makers. Most of the engineering drawings are complete; however, these will be updated after the contract is awarded for the second ASDS boat.



ASDS Program

Technology Maturity

Two of ASDS' three critical technologies—the battery and the propulsion—have not reached maturity, and they are not expected to be mature before the production decision for additional boats.

The silver-zinc propulsion battery has experienced premature failures and short demonstrated life. Although the Navy continues to mature the silver-zinc battery for the first boat, it intends to replace it with a lithium-ion battery. The Navy has three contractors exploring this technology. Two contracts were awarded to identify and test viable lithium-ion battery technology for a battery that can be housed inside the existing ASDS titanium battery bottles. Program officials expect to receive battery samples in early 2004. A third contractor is developing an alternative design for a battery that is contained in fiberglass housings and will fit in the same area as the existing silver-zinc battery. Lithium-ion battery technology, like silver-zinc, is not new; however, the challenge lies in adapting the technology to ASDS' size and environment.

The most significant noise offender, the propeller, was replaced with a composite propeller before operational test and evaluation. However, acoustic measurements have not been made, and other acoustic signature issues still need to be addressed. The acoustic requirement has been deferred until delivery of the second ASDS boat.

Design Maturity

About 99 percent of the 4,999 engineering drawings have been released to manufacturing for the second ASDS boat. After contract award for the second ASDS boat, the contractor will prepare revised and new drawings to account for part item substitutions, and to reflect updates in commercial off-the-shelf equipment availability, especially for the integrated control and display system.

The first ASDS boat has not demonstrated the ability to meet all of the program's key performance parameters. Specifically, the first boat is not quiet enough to meet acoustic stealth requirements, and compliance with survivability requirements has not yet been verified and approved. In addition, the Navy's operational evaluation of ASDS included numerous recommendations to correct deficiencies and vulnerabilities and recommended additional operational testing and evaluation to verify corrections prior to full operational capability.

According to the program office, the follow-on ASDS boats—numbers two through six—will be substantially similar to ASDS-1. It believes the above changes and the change to a lithium-ion battery will have only minor affects on the design. However, until survivability issues 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.

Other Program Issues

Future testing issues could affect the program, but these results will not be known before the production decision for additional boats scheduled in early 2004. For example, the Commander, Operational Test and Evaluation Force, recommended an additional phase of operational test and evaluation to verify that deficiencies and vulnerabilities identified during the May 2003 operational evaluation are corrected prior to full operational capability. In addition, since the program's first cost estimate was originally approved in 1994, research and development costs have more than tripled, and the Navy has not yet issued an updated cost estimate for follow-on boats and has not provided a life-cycle cost estimate for the ASDS program.

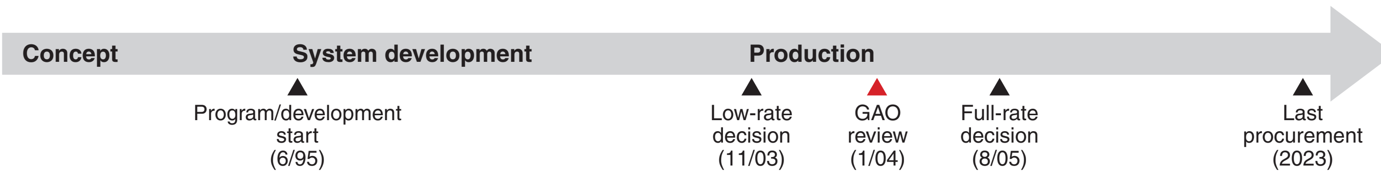
Program Office Comments

The ASDS program office provided technical comments, which were incorporated as appropriate.

Advanced Threat Infrared Countermeasure/Common Missile Warning System

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

Source: BAE Systems.



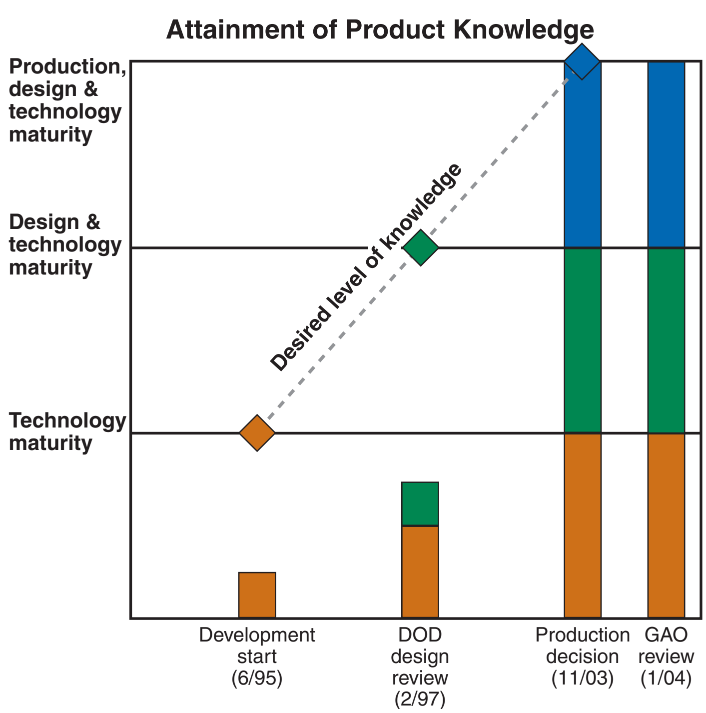
Program Essentials

Prime contractor: BAE Systems North America
Program office: Huntsville, Ala.
Funding needed to complete:
- R&D: $61.4 million
- Procurement: $2,608.6 million
- Total funding: $2,670.0 million
- Procurement quantity: 2,673

Program Performance (fiscal year 2004 dollars in millions)

	As of 03/1996	Latest 10/2003	Percent change
Research and development cost	$568.6	$601.7	5.8
Procurement cost	$2,325.5	$2,695.9	15.9
Total program cost	$2,894.1	$3,297.6	13.9
Program unit cost	**$0.935**	**$1,220**	**30.4**
Total quantities	3,094	2,704	-12.6
Acquisition cycle time (months)	TBD	TBD	TBD

The ATIRCM/CMWS program entered production in November 2003 with technologies mature, designs stable, and production processes in 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.



ATIRCM/CMWS Program

Technology Maturity

The ATIRCM/CMWS' five critical technologies are mature. However, they did not mature until after the design review in February 1997. Most of the early technology development effort was focused on the application to rotary wing aircraft. When system development began in 1995, the requirements were expanded to include Navy and Air Force fixed wing aircraft. This change caused problems that largely contributed to cost increases of more than 150 percent to the development contract. The Navy and the Air Force subsequently dropped out of the program, rendering the extra effort needless.

Design Maturity

The basic design of the system is complete with 100 percent of the drawings released to manufacturing. The design was not mature at the time of the design review, with only 22 percent of the drawings complete. This was primarily due to the expanded requirements. It was not until 2 years after the design review that 90 percent of the drawings were released and the design was considered stable. This resulted in inefficient manufacturing, rework, additional testing, and a 3-year schedule delay.

Production Maturity

The ATIRCM/CMWS program has all 15 key manufacturing processes in control. The Army entered limited CMWS production in February 2002 to meet an urgent need of the Special Operations Command. The ATIRCM subsystem's production was delayed due to reliability testing failures. The program is implementing reliability fixes to six production representative subsystems that will be used for initial operational test and evaluation. The subsystems will be delivered in March 2004. The full-rate production decision for the complete system is now scheduled for 2005.

Other Program Issues

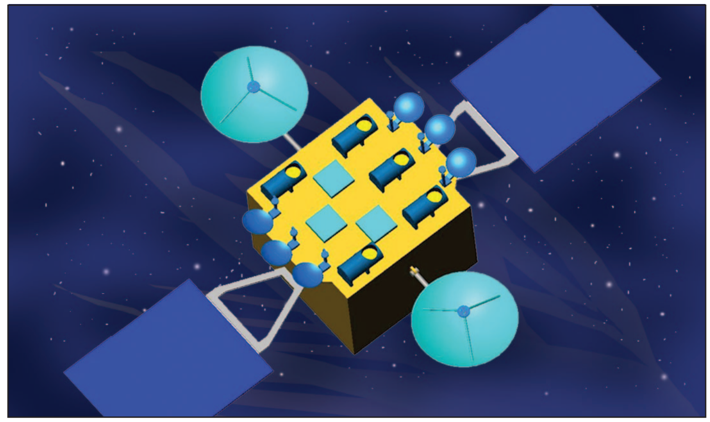
The Army procured an initial 32 systems for use on Special Operations' CH-47 helicopters in fiscal year 2002 that only included CMWS. The Army plans to procure a total of 99 systems to outfit Special Operations' aircraft between fiscal years 2003 and 2009.

Program Office Comments

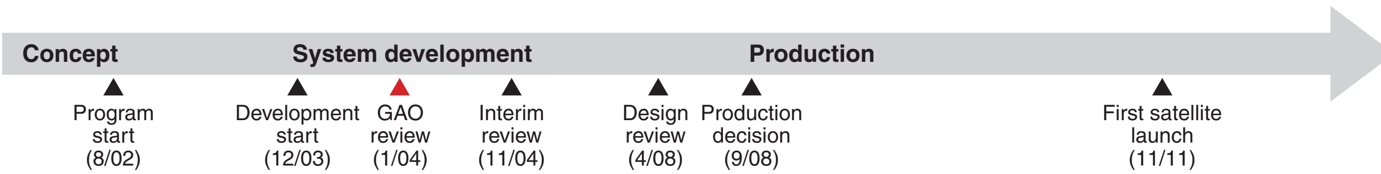
The ATIRCM/CMWS program office concurred with this assessment and provided technical comments, which were incorporated where appropriate. Additionally, it commented that the Army acquisition executive approved the Army Systems Acquisition Review Council's recommendation that ATIRCM/CMWS transition from system development and demonstration to production and deployment. Initial operational tests and evaluation will be completed in fiscal years 2004 and 2005. A full-rate production decision review is planned in August 2005.

Advanced Wideband Satellite/Transformational Satellite (AWS/TSat)

The AWS/TSat system is designed to provide improved, survivable, jam-resistant, worldwide, secure, and general purpose communications to support DOD in conjuction with systems that support NASA and the intelligence community. It will replace the current Milstar satellite system and supplement the AEHF satellite system, reviewed elsewhere in this report. It will include multiple satellite systems and be a cornerstone of the new DOD communications architecture.



Source: U.S. Air Force.



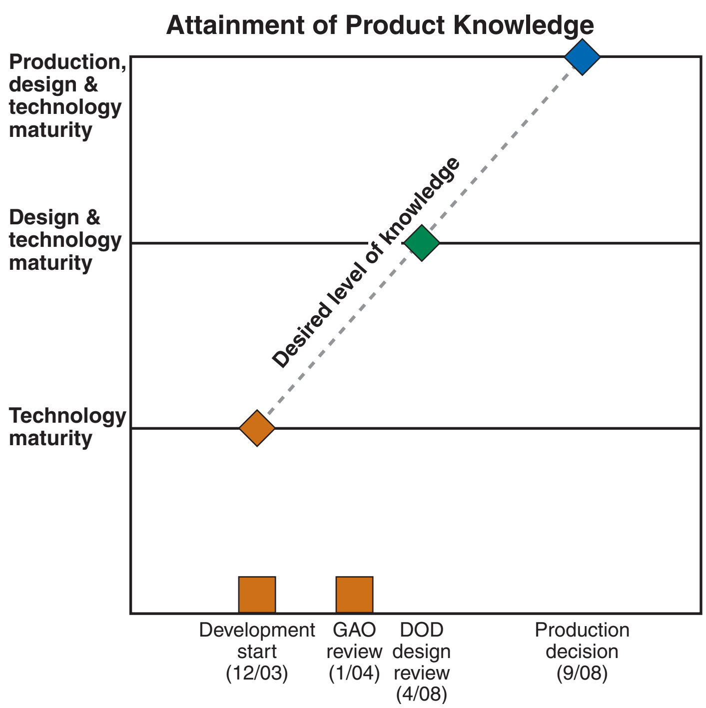
Program Essentials

Prime contractor: In Competition
Program office: El Segundo, Calif.
Funding needed to complete:
- R&D: TBD
- Procurement: TBD
- Total funding: TBD
- Procurement quantity: 8

Program Performance (fiscal year 2004 dollars in millions)

	As of 08/2002	Latest 01/2004	Percent change
Research and development cost	$5,901.8	$12,525.5	112.2
Procurement cost	$2,379.1	$7,928.7	233.3
Total program cost	$8,281.0	$20,528.1	147.9
Program unit cost	**$2,070.240**	**$2,052.814**	**-0.8**
Total quantities	4	10	150.0
Acquisition cycle time (months)	75	95	26.7

The AWS/TSat program entered system development in December 2003 with only one of its five critical technologies mature. The remaining four technologies are not expected to reach maturity until 2006. The product development period requires concurrent technology maturation and product development activities to maintain schedule.



AWS/TSat Program

Technology Maturity

Of the five AWS/TSat critical space technologies, one is mature while the other four are scheduled to reach maturity in early 2006, more than 2 years after the planned start of development. Three of the four immature technologies have a backup technology available in case of development difficulties. However, use of any of the backup technologies would degrade overall system performance. The Single Access Laser Communications technology has no backup, and according to program officials, any delay in maturing this technology would cause the expected first satellite launch date to slip beyond 2011.

Other Program Issues

The AWS/TSat acquisition strategy allows the system's technology development and product development to be conducted concurrently prior to the production decision. Because the military users expect new communications capability by 2011 and they were concerned with the aggressive acquisition strategy of the AWS/TSat program, the Air Force scheduled an interim review point in November 2004. The review is intended to determine if technology development has progressed sufficiently to ensure the military users' needs can be met no later than 2011. If not, the Air Force must decide on alternatives, one of which is to buy an additional AEHF satellite. Air Force officials have not defined the evaluation criteria they intend to use to assess AWS/TSat's progress or determine alternatives.

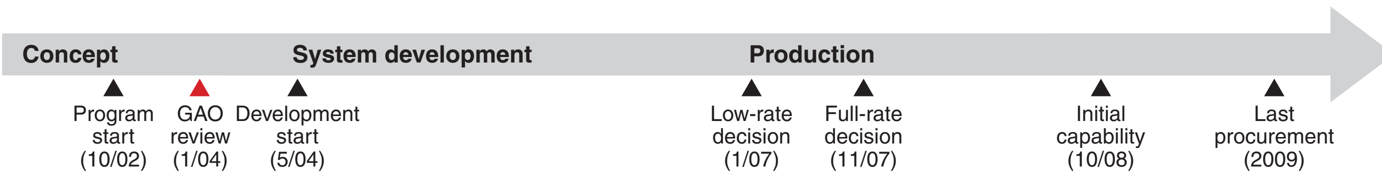
Program Office Comments

In commenting on a draft of this assessment, the program office stated that the current AWS/TSat development plan matures all critical path technologies sufficiently before the preliminary design review. The Air Force believes this is consistent with both government and commercial best practices. Furthermore, it noted that nearly all technologies that are not now mature have backup technologies that provide significantly increased capability to the warfighter. The only exception is the laser communications subsystem that it believes is a low risk for production.

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 between the B-2 and a commercial communication satellite system under development. 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.



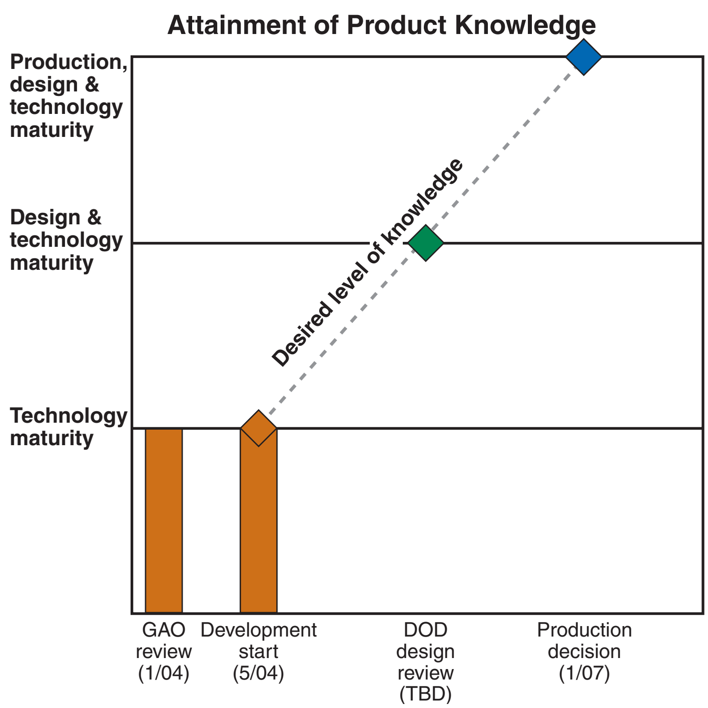
Program Essentials

Prime contractor: Northrop Grumman
Program office: Dayton, Ohio
Funding needed to complete:
- R&D: $696.1 million
- Procurement: $498.9 million
- Total funding: $1,195.0 million
- Procurement quantity: 21

Program Performance (fiscal year 2004 dollars in millions)

	As of 10/2003	Latest 10/2003	Percent change
Research and development cost	$779.7	$779.7	0.0
Procurement cost	$498.9	$498.9	0.0
Total program cost	$1,278.6	$1,278.6	0.0
Program unit cost	**$60.887**	**$60.887**	**0.0**
Total quantities	21	21	0.0
Acquisition cycle time (months)	72	72	0.0

The B-2 RMP's two critical technologies are fully mature well in advance of development start, scheduled for May 2004. A date has not been set for the final design readiness review. The program plans to build six radar units during development for pilot training with the B-2 operational wing. These prototypes will later become operational units on the B-2 aircraft.



B-2 RMP Program

Technology Maturity

The B-2 RMP's two critical technologies, the transmit/receive modules of the AESA antenna and the beam steering controller software, appear mature. A formal technology readiness assessment is planned for completion prior to the start of development in May 2004. In an effort to further reduce risk, the program has already built and tested some transmit/receive modules. In addition, several key elements of the modules have already been tested in an operational environment. Over half of the beam steering controller software has been demonstrated on prior AESA upgrade programs.

Design Maturity

The contractor built and tested some transmit/receiver modules as part of a proof-of-design phase prior to the start of development. However, the contractor has not released any manufacturing drawings because the program is not scheduled to start development until May 2004. A date has not yet been set for the final design readiness review.

Production Maturity

Both the prime contractor and the major subcontractor plan to collect manufacturing process control data. Production is scheduled to begin in January 2007. The program plans to conduct a production readiness review prior to the planned start of production. 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 six radar units during development and later modify these units for placement on operational B-2 aircraft. The Air Force needs these six radar units when the current B-2 radar frequency becomes unavailable, in order to continue vital air crew training and proficiency operations. Building these six units early in development adds risk because most of the radar flight-test activity will not occur until after these units are built.

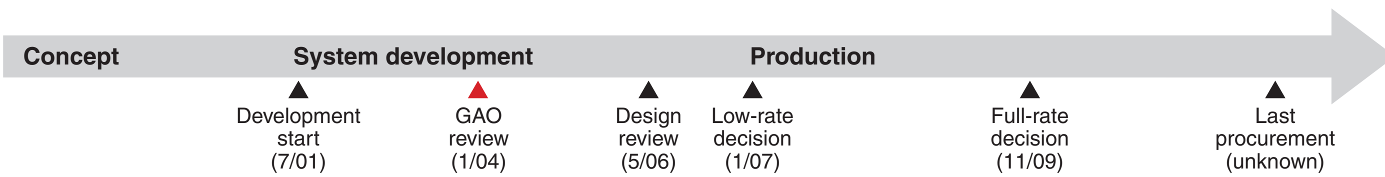
Program Office Comments

The B-2 Program Office concurred with this assessment.

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

The C-130 AMP standardizes the cockpit configurations and avionics for all 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.

Source: The Boeing Company.



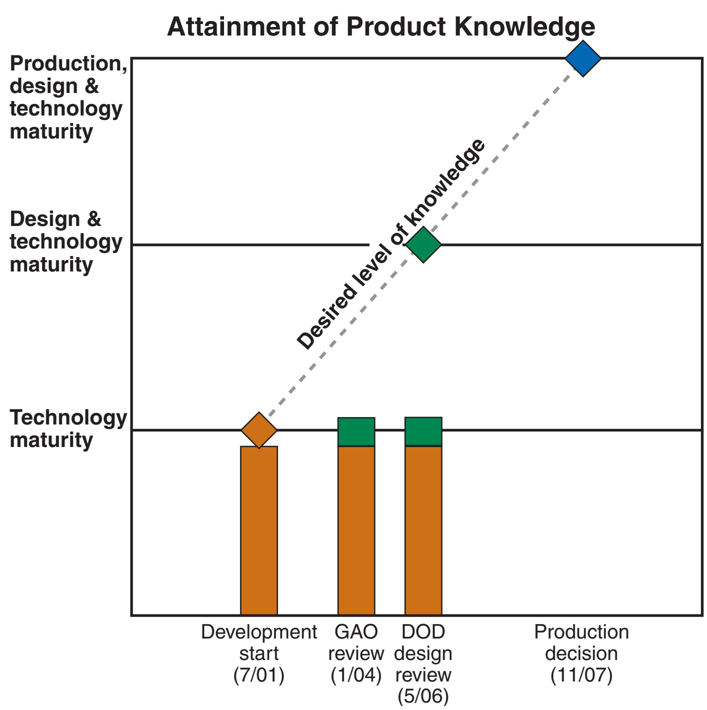
Program Essentials

Prime contractor: Boeing
Program office: Dayton, Ohio
Funding needed to complete:
- R&D: $900.2 million
- Procurement: $2,876.1 million
- Total funding: $3,776.3 million
- Procurement quantity: 479

Program Performance (fiscal year 2004 dollars in millions)

	As of 07/2001	Latest 09/2003	Percent change
Research and development cost	$657.4	$1,214.8	84.8
Procurement cost	$2,846.0	$2,876.1	1.1
Total program cost	$3,503.5	$4,090.9	16.8
Program unit cost	**$6.750**	**$8.349**	**23.7**
Total quantities	519	490	-5.6
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 all but one of its six critical technologies mature. The remaining technology is nearing full maturity; however, there is concern that it may not meet current performance requirements. Program officials are working with the user to lower requirements to match resources. Program officials plan to release 90 percent of engineering drawings by the design review. The program office recently delayed program milestones in response to funding reductions. While this delay provides extra time to achieve design stability, it reduces the time available to achieve production knowledge. Plans to accelerate the installation on Special Operations aircraft and software integration challenges are placing additional pressure on the compressed schedule.



C-130 AMP Program

Technology Maturity

Five of the C-130 AMP's critical technologies are fully mature. The program utilizes primarily proven commercial and modified off-the-shelf technology for all AMP capabilities. The remaining critical technology, the Terrain Following and Terrain Avoidance (TF/TA) capability, has been demonstrated through the Air Force Research Lab's Quiet Knight advanced technology demonstration program, and it is nearing full maturity. There is a risk that the TF/TA technology may not meet a key requirement to operate at 250 feet. Program officials are working with the user to lower the requirements to operate between 250 and 1,000 feet, which will more closely match the capability of the TF/TA technology. Failure to make this change may necessitate a redesign.

Design Maturity

Currently, 14 percent of the design drawings are complete and could be released to manufacturing. Program officials stated they are committed to meeting the required 90 percent drawing release by design review, now scheduled for May 2006.

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. Future spirals are planned for Special Operations Command's C-130 aircraft because they require additional, unique defensive systems integration and enhanced situational awareness.

Other Program Issues

Funding reductions in fiscal years 2003 and 2004 delayed the C-130 AMP's development program and resulted in a rescheduling of program milestones. The design review, low-rate initial production, and production readiness decisions have all been delayed. Program officials stated that the delay in schedule would provide more time to resolve issues with the TF/TA technology and software. Despite this additional time, the time available for system integration has been compressed by 9 months, giving less time to reduce manufacturing risks. There is also a new plan to accelerate Special Operations Command aircraft deliveries by 12-14 months, further compressing an already optimistic timeline.

The program is also at risk if less software is reused than originally estimated, which may cause an increase in development costs and delay the program's schedule. Software integration remains a risk due to its complexity, number of suppliers, potential for developmental growth, certification of a secure operating system, and software safety standards. The program office is working to mitigate these risks through modeling and simulation, utilizing the systems integration laboratory built by the contractor, and through flight demonstrations.

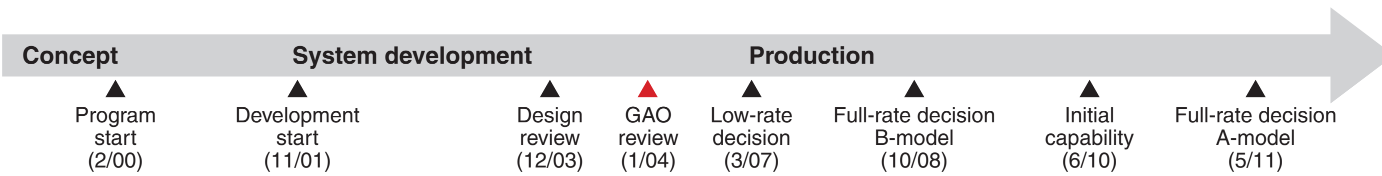
Program Office Comments

In commenting on a draft of this assessment, program officials stated that the technology demonstrated during the Quiet Knight demonstration is mature and that the remaining technological challenge lies in integrating all TF/TA system components and coupling them with the other avionics functions. An early study identified a risk that the TF/TA system may not meet a key requirement to operate at 250 feet caused by errors attributable to the integrated subsystems. The study identified fixes to minimize errors, and program officials stated they worked closely with the user and the contractor for implementation to ensure a match between requirements and the TF/TA System capabilities. Only this key engineering requirement was loosened to match the capability of the currently fielded systems. Program officials further stated that the risk of the compressed schedule should be reduced by a robust predevelopment test and evaluation TF/TA flight demonstration and having two aircraft in development testing.

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 and 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, provided for GAO by the United States Air Force.



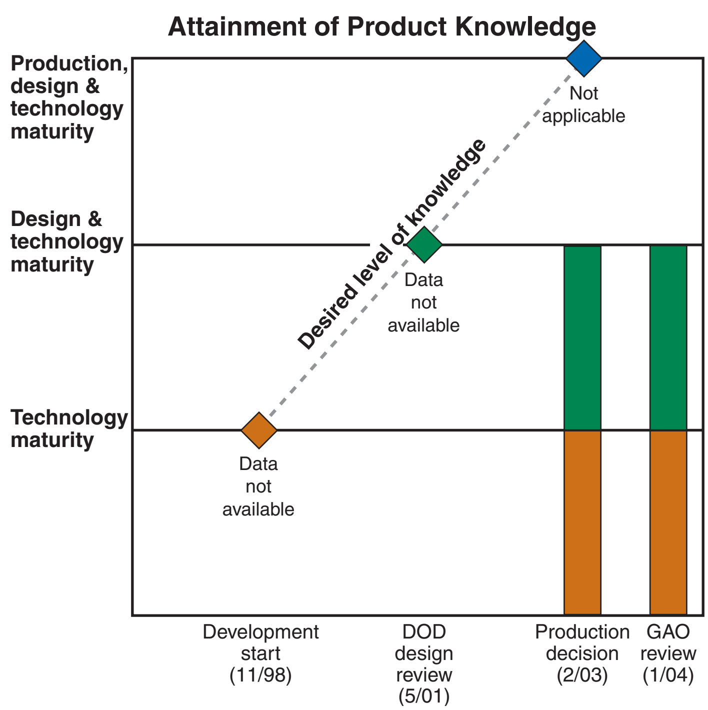
Program Essentials

Prime contractor: Lockheed Martin
Program office: Dayton, Ohio
Funding needed to complete:
- R&D: $76.3 million
- Procurement: $280.1 million
- Total funding: $356.3 million
- Procurement quantity: 45

Program Performance (fiscal year 2004 dollars in millions)

	As of 11/1998	Latest 10/2003	Percent change
Research and development cost	$340.2	$367.9	8.2
Procurement cost	$595.0	$404.5	-32.0
Total program cost	$935.2	$772.4	-17.4
Program unit cost	**$7.422**	**$14.043**	**89.2**
Total quantities	126	55	-56.3
Acquisition cycle time (months)	83	83	0.0

The program office considers the C-5 AMP's critical technologies to be mature because they are relying on commercial off-the-shelf technologies that are installed in other commercial and military aircraft. The main challenge involves the development and integration of software. The Air Force plans to modify 55 of the 112 C-5 aircraft, and the program office has let the production contract for the first 8 C-5 AMP modifications. The Air Force is also seeking funding to modify the remaining 57 C-5s; however, that decision will not be made until the Air Force determines whether it will use C-17s instead of the C-5s to meet its airlift requirements. If the Air Force decides to use the C-17s, it may not upgrade some, or all, of the remaining 57 C-5s.



C-5 AMP Program

Technology Maturity

We did not assess the C-5 AMP's critical technologies as the program used commercial technologies that are considered mature. Program officials indicated that the technologies are in use on other aircraft. 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 Maturity

The design appears stable as the contractor has released 100 percent of the drawings for the AMP. In addition, the seven major subsystem-level design reviews were completed before the December 2003 system-level design review. Demonstration of these integration activities is scheduled during development test and evaluation, which was started in December 2002 and should be completed in October 2004.

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 (GPS), 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 installation schedules.

Other Program Issues

Program officials indicated the greatest risk to the AMP is software development and integration. Several new software programs must be developed and integrated with several other commercial off-the-shelf software packages. Program officials stated that the software development risks stem from a variety of issues, including an aggressive cost and schedule baseline and a geographically diverse software development team. To overcome these problems, the prime contractor added additional staff. Program officials are confident that the problems will be satisfactorily resolved within the current schedule.

The C-5 aircraft must undergo the AMP modifications prior to the RERP modifications. However, only 55 aircraft have been approved for the AMP upgrades, while 112 are awaiting RERP upgrades. The Air Force needs to determine how many of the remaining 57 C-5s will receive the AMP upgrades. That decision will not be made until the Air Force determines the correct mix of C-5 and C-17 aircraft that are needed to meet DOD's airlift needs. Until it is decided whether to use C-17s to replace some, or all, of the earlier 57 C-5s, the number of aircraft to undergo the AMP and RERP modernization will remain uncertain.

Program Office Comments

In commenting on the draft of this assessment, the program office said that the cost comparison of the November 1998 AMP position to the latest AMP position, for the purpose of calculating a percentage change to the unit cost, does not accurately portray the program's cost growth. The November 1998 position represents the original 126-aircraft program. The program has since been restructured to a 55-aircraft program. Such a change would increase costs by a large amount because it would be less expensive, on a unit cost basis, to procure a greater number of aircraft than it would be to procure fewer aircraft.

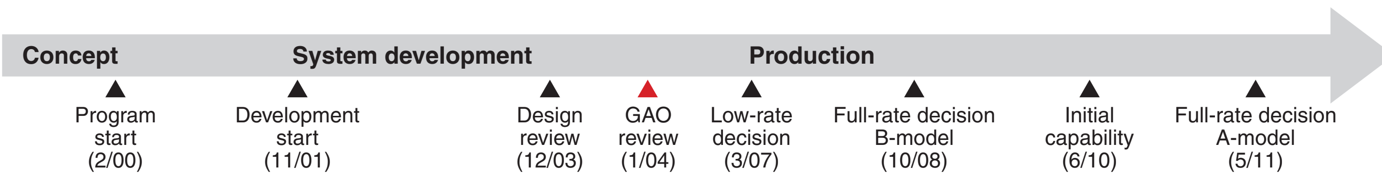
GAO Comments

While the program has established a new cost and performance baseline since the November 1998 decision to begin development, the comparison presented provides an accurate picture of change since that major decision. Although DOD may update its baseline for management purposes, our goal is to provide an aggregate or overall picture of the program's history.

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 aircraft. The RERP is designed to enhance the reliability of the aircraft by replacing engines and modifying subsystems such as the electrical, fuel, hydraulic, and flight controls systems, while the C-5 AMP is designed to enhance the avionics. These upgrades are part of a two-phased modernization effort to improve the mission capability rate and transport capabilities and reduce ownership costs. We assessed the C-5 RERP.

Source: Lockheed-Martin Aero.



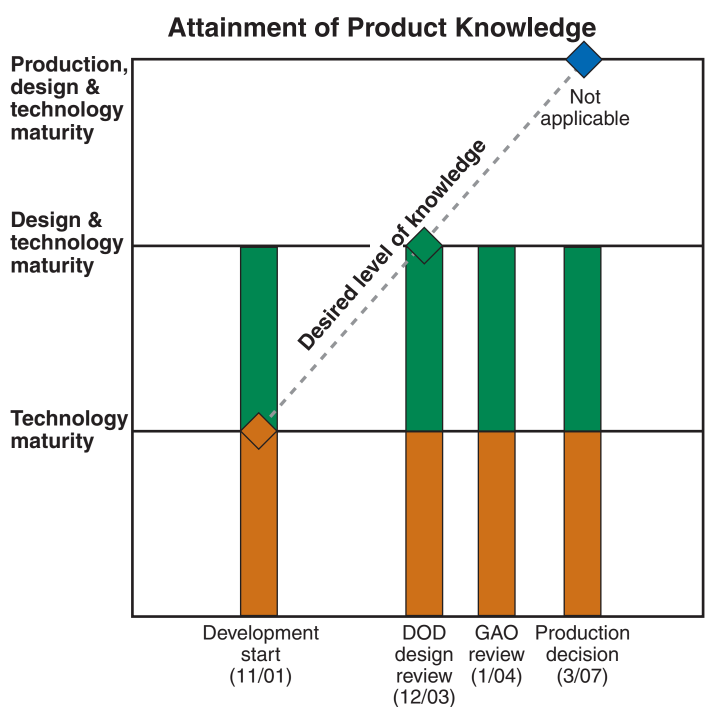
Program Essentials

Prime contractor: Lockheed Martin
Program office: Dayton, Ohio
Funding needed to complete:
R&D: $1,093.2 million
Procurement: $7,514.1 million
Total funding: $8,610.7 million
Procurement quantity: 109

Program Performance (fiscal year 2004 dollars in millions)

	As of 11/2001	Latest 12/2002	Percent change
Research and development cost	$1,485.8	$1,472.4	-0.9
Procurement cost	$7,756.4	$7,514.1	-3.1
Total program cost	$9,245.5	$8,989.8	-2.8
Program unit cost	**$73.377**	**$80.296**	**9.4**
Total quantities	126	112	-11.1
Acquisition cycle time (months)	100	103	3.0

The program ensured that the technology was mature and that the design was stable at critical points in development, closely tracking best practice standards. The RERP is utilizing demonstrated commercial off-the-shelf components that require little or no modification. The major challenge to the RERP is software development and integration, which has experienced problems. Also, the RERP is dependent on the number of aircraft approved to undergo the C-5 AMP upgrades. Until additional aircraft are approved for the C-5 AMP, it is uncertain how many aircraft will undergo the RERP.



C-5 RERP Program

Technology Maturity

The C-5 RERP 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 airlines. According to the Air Force technology assessment, these engines have over 70 million flying hours of use.

Design Maturity

The C-5 RERP design is mature. As of November 2003, 98 percent of the design drawings were complete. In addition, the seven major subsystem-level design reviews were completed before the December 2003 system-level design review.

According to program officials, the greatest risk to the C-5 RERP is software development and integration activities. Several new software programs must be developed and integrated together as well as with other commercial off-the-shelf software packages. The program has experienced problems during software development and integration, and it believes these problems are linked to pressures caused by an aggressive cost and schedule baseline and different geographical locations of the software development team. A program official stated that the prime contractor has started to take actions to improve program software development activities.

Production Maturity

We did not assess the C-5 RERP production maturity because the Air Force is buying commercially available items. However, we expect that production maturity would be at a high level.

Other Program Issues

The C-5 RERP is dependent on the C-5 AMP, as the aircraft has to undergo avionics modernization prior to the RERP. The C-5 RERP has been authorized for 112 of the C-5 aircraft, but the AMP has only been authorized for 55 aircraft. Therefore, until the Air Force decides on how many C-5 aircraft will undergo avionics modernization, it is uncertain how many aircraft will undergo the RERP upgrades.

Program Office Comments

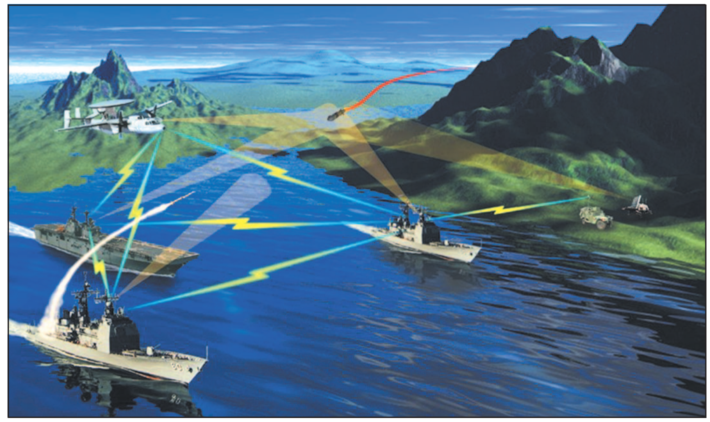
In commenting on the draft of this assessment, the program office stated that the cost comparison of the November 2001 RERP position to the latest RERP position, for the purpose of calculating a percentage change to the unit cost, does not accurately portray the program's cost growth. The November 2001 position represents the original 126-aircraft program. The program has since been restructured to a 112-aircraft program. It further stated that such a change would increase costs by a large amount because it would be less expensive, on a unit cost basis, to procure a greater number of aircraft than it would be to procure fewer aircraft.

GAO Comments

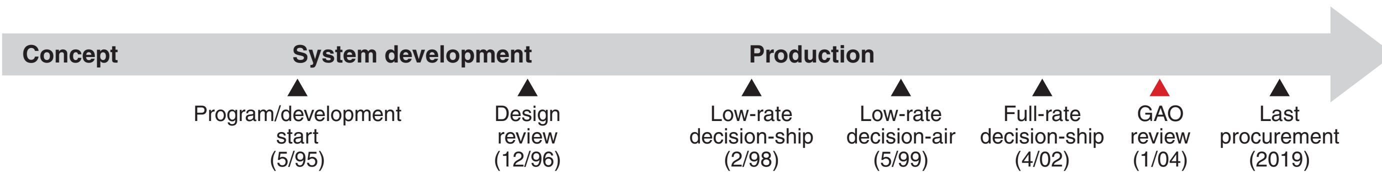
While the program has established a new cost and performance baseline since the November 2001 decision to begin development, the comparison presented provides an accurate picture of change since that major decision. Although DOD may update its baseline for management purposes, our goal is to provide an aggregate or overall picture of the program's history.

Cooperative Engagement Capability (CEC)

The Navy's CEC is designed to connect radar systems to enhance detection and engagement of air targets. Ships and planes equipped with their version of CEC hardware and software will share real-time data to create composite radar tracks—allowing the battle group to see the same radar picture. A CEC-equipped ship can then detect and launch missiles against targets its radar cannot see. We assessed the current shipboard and airborne versions of CEC.



Source: CEC Program Office.



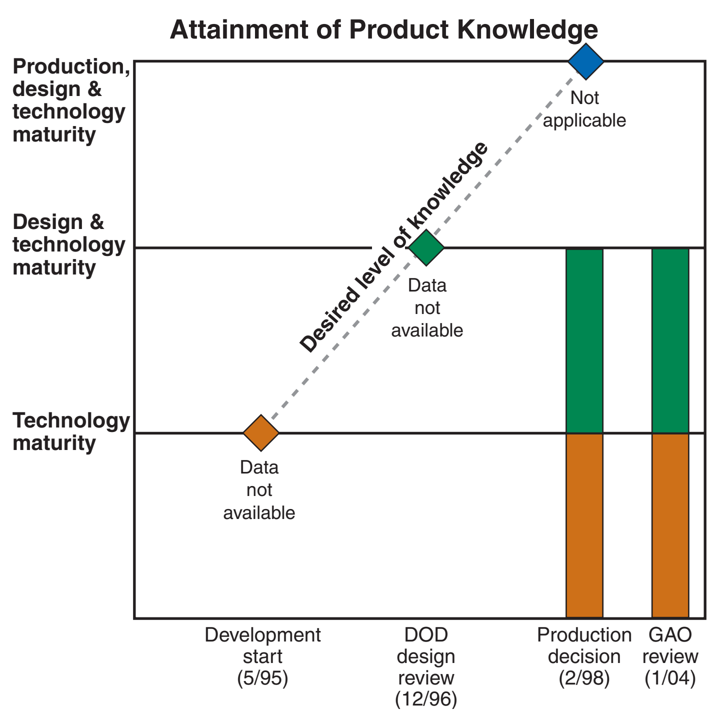
Program Essentials

Prime contractor: Raytheon Systems Corporation
Program office: Washington, D.C.
Funding needed to complete:
- R&D: $487.0 million
- Procurement: $1,353.1 million
- Total funding: $1,840.1 million
- Procurement quantity: 221

Program Performance (fiscal year 2004 dollars in millions)

	As of 05/1995	Latest 10/2003	Percent change
Research and development cost	$1,157.2	$2,431.2	110.1
Procurement cost	$1,291.9	$2,066.3	59.9
Total program cost	$2,495.4	$4,497.5	80.2
Program unit cost	**$13.636**	**$14.942**	**9.6**
Total quantities	183	301	64.5
Acquisition cycle time (months)	16	16	0.0

CEC's production maturity could not be assessed because the government does not collect the necessary data on the commercially available portions of the shipboard and airborne versions of CEC. However, program and contractor officials consider the production processes to be capable of producing a quality product on time and within cost. The technologies and design of both the shipboard and airborne versions are fully mature. In April 2002, the shipboard version was approved for full-rate production, and the airborne version was approved for continued low-rate initial production.



CEC Program

Technology Maturity

All six of CEC's critical technologies are considered mature, based on operational assessments by the Office of Naval Research issued in January 2002. While the shipboard and airborne versions have different hardware, they share the same six critical technologies.

Design Maturity

CEC's basic design appears stable. All drawings needed to build the shipboard and airborne versions have been released to manufacturing.

CEC program officials noted that new drawings for both versions will continue to be released. They explained that as commercially available technologies, which comprise approximately 60 percent of the CEC hardware, become more advanced, portions of the system will need to be redesigned to incorporate those advances.

Production Maturity

We could not assess production maturity as data was not available. According to program officials, the noncommercially available portions of CEC do not involve any critical manufacturing processes. Officials indicated that they do not have insight into the manufacturing processes for the commercially available portion, including whether these processes are critical and whether the contractor has them under statistical control.

Program officials and the contractor are confident that a quality product can be delivered on time and within cost based on the contractor's adherence to industry standards and past performance on low-rate initial production contracts for the shipboard version. Also, according to program officials, a production readiness review of the airborne version is planned for the second quarter of fiscal year 2004.

Other Program Issues

In November 2003, the Navy announced plans to resolve outstanding issues associated with CEC's interoperability by pursuing open architecture and functionality changes in coordination with the Joint Single Integrated Air Picture Systems Engineering Organization (JSSEO). The CEC Program Office then discontinued planning for a Block 2 development effort and began working with JSSEO to jointly engineer sensor measurement and radar tracking management solutions. According to the CEC Program Office, the JSSEO's goal is to have a common set of solutions available to all services to implement, thereby ensuring optimum interoperability across the battlespace.

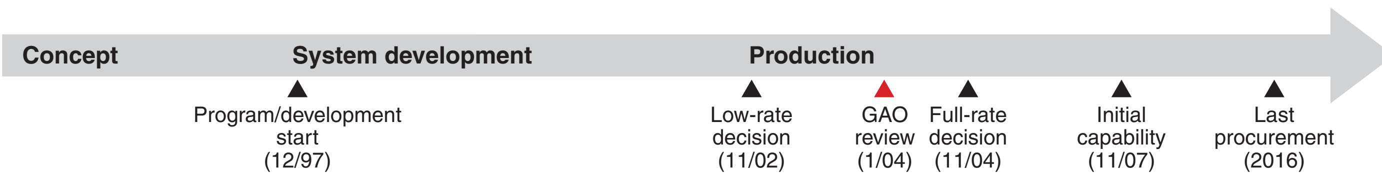
Program Office Comments

In commenting on a draft of this assessment, the program office stated that it generally concurred with our assessment. The program office also noted it will be incorporating a new antenna assembly, which is a critical technology, into the shipboard version starting in fiscal year 2005. This antenna assembly will eliminate the current need for two antenna arrays on some ships. The new antenna array, which is expected to be less expensive, will be produced using commercial processes. The program office plans to hold a production readiness review on the new antenna assembly in the second quarter of fiscal year 2004.

CH-47F Improved Cargo Helicopter (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 purpose of the CH-47F program is to enhance performance and extend the useful life of the CH-47 helicopter. This effort includes installing a digitized cockpit, rebuilding the airframe, and reducing aircraft vibration.

Source: Boeing Helicopters.



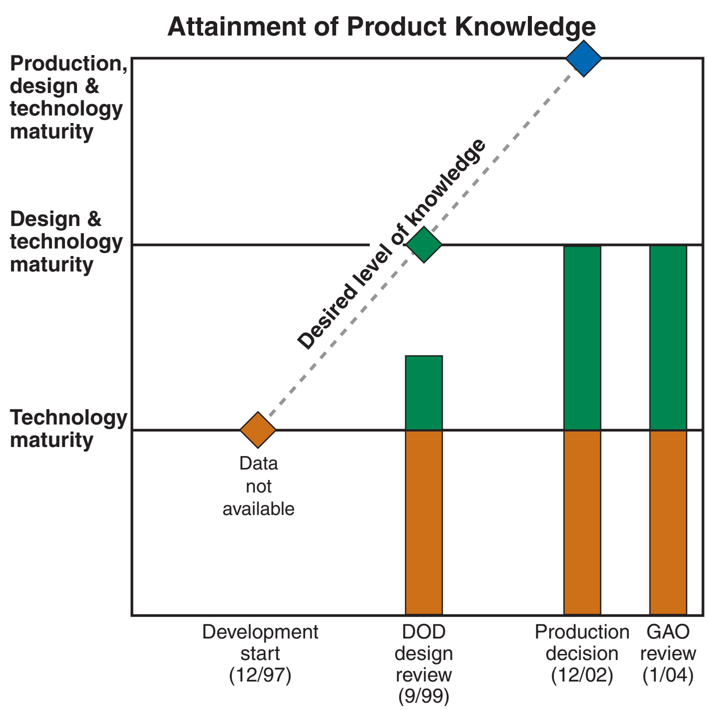
Program Essentials

Prime contractor: Boeing Helicopters
Program office: Huntsville, Ala.
Funding needed to complete:
- R&D: $10.4 million
- Procurement: $5,594.9 million
- Total funding: $5,605.3 million
- Procurement quantity: 330

Program Performance (fiscal year 2004 dollars in millions)

	As of 05/1998	Latest 09/2003	Percent change
Research and development cost	$147.4	$170.0	15.3
Procurement cost	$2,582.3	$6,013.4	132.9
Total program cost	$2,729.7	$6,183.5	126.5
Program unit cost	**$9.039**	**$18.240**	**101.8**
Total quantities	302	339	12.3
Acquisition cycle time (months)	81	119	46.9

The CH-47F helicopter began low-rate production in December 2002, although key production processes were not in control. Program officials believe that production is low risk because no new technology is being inserted into the aircraft, two prototypes have been produced, and the production process has been demonstrated during the development phase. The CH-47F technologies and design appear mature, although a low percentage of engineering drawings were released at the design review. In 2002, production unit costs more than doubled due to contractor rate increases, new system requirements, and initial underestimation of program cost.



CH-47F Program

Technology Maturity

Although we did not assess technology maturity in detail, the CH-47F helicopter 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 Maturity

The CH-47F design is complete, with 100 percent of the drawings released to manufacturing. However, at the design review only 37 percent of the system's engineering drawings were complete. Since that time, the number of drawings completed increased substantially. The majority of the new drawings were instituted to correct wire routing and installation on the aircraft, changes the program office believed could not be determined until after the first prototype was developed.

Production Maturity

The CH-47F's production maturity could not be determined because statistical process control data was not available. According to Boeing, this data is available at the contractor; however, the CH-47F program is not reviewing it. Although program office officials believe the CH-47F's production is low risk, because two prototypes were produced during development, there is no evidence to show that its critical manufacturing processes are under control. In the absence of this data, the program office started its second low-rate initial production in December 2003.

Other Program Issues

In addition to the cost increases experienced in the CH-47F program last year, further cost increases and schedule delays are expected due to DOD's direction to remanufacture more helicopters for the Special Operations Command, which have not yet been reflected in the costs of the program. According to the CH-47F deputy program manager, DOD directed the Army to remanufacture an additional 16 MH-47G helicopters for the Special Operations Command before the start of the Army's low-rate initial production for its CH-47F helicopters. The program office maintains that DOD's decision affected the program's cost and schedule estimates and resulted in a schedule rebaselining of the CH-47F program. The restructuring will result in a schedule slippage of 15 months and a cost increase of about $630 million, the majority of which will go toward replacing helicopters provided to the Special Operations Command.

Program Office Comments

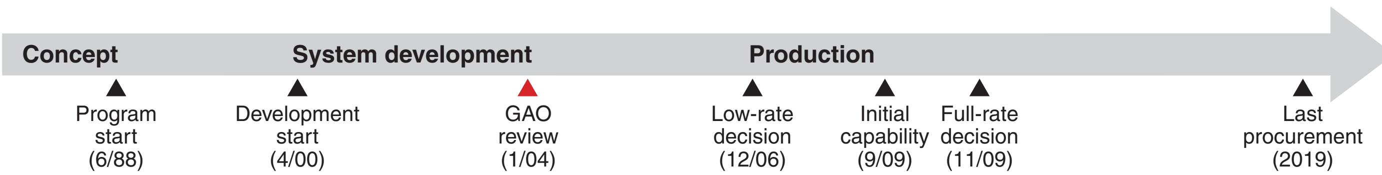
In commenting on a draft of this assessment, the CH-47F product manager generally concurred with this assessment, but provided clarifying comments. Regarding manufacturing control processes, the CH-47F product manager stated that quality control measures that are more realistic than the statistical process control metrics are in place and are being monitored to ensure production maturity. For example, both contractor and government personnel are inspecting all flight safety parts, and the program office reviews this data monthly.

The product manager believes that the initial program cost increase associated with the additional helicopters for the Special Operations Command has been absorbed into the current program and will have a minimal effect on average unit cost. Further, a revised program deviation report addressing the schedule slip for the first unit-equipped date is pending approval by the Army acquisition executive.

Comanche Reconnaissance Attack Helicopter (RAH-66)

The Army has terminated the Comanche program to reallocate resources. It was the Army's next generation armed reconnaissance aircraft system and its technology would have provided the Army with a system capable of operating in adverse weather conditions across a wide spectrum of threat environments. It would have replaced AH-1, OH-6, and OH-58A/C/D helicopters. We have retained the Comanche assessment because it remains a good example of attaining key product knowledge.

Source: Boeing Sikorsky.



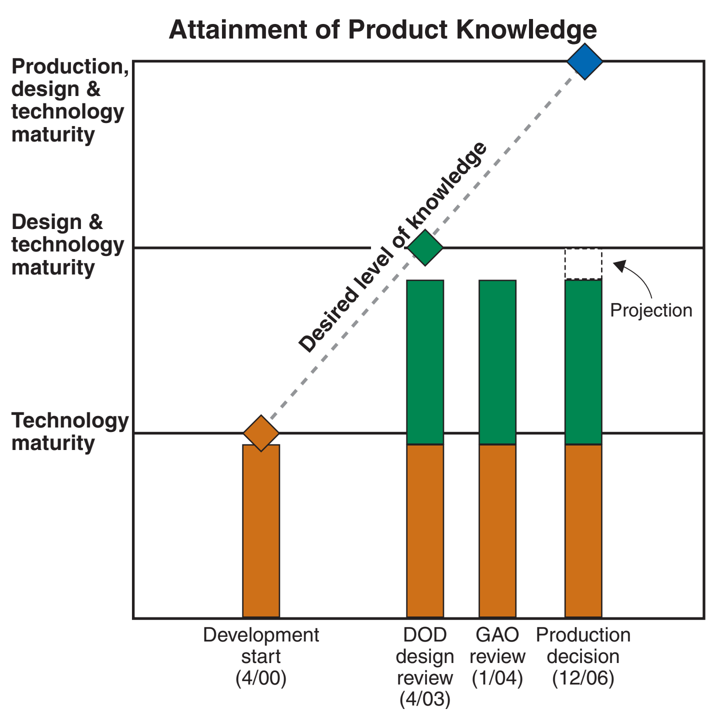
Program Essentials

Prime contractor: Boeing Sikorsky
Program office: Huntsville, Ala.
Funding needed to complete:
R&D: $4,968.8 million
Procurement: $21,955.4 million
Total funding: $26,962.7 million
Procurement quantity: 646

Program Performance (fiscal year 2004 dollars in millions)

	As of 07/2000	Latest 12/2002	Percent change
Research and development cost	$8,905.1	$12,572.5	41.2
Procurement cost	$30,573.4	$21,955.4	-28.2
Total program cost	$39,865.6	$34,577.0	-13.3
Program unit cost	**$32.865**	**$53.195**	**61.9**
Total quantities	1,213	650	-46.4
Acquisition cycle time (months)	223	256	14.8

Most critical technologies have demonstrated acceptable levels of maturity, and the program has confirmed the stability of the first design iteration through its recent critical design review. This level of maturity follows years of difficult development. In 2002, the program was restructured to incorporate an evolutionary acquisition approach and reduce concurrency and lower overall risk. The restructured program includes aspects of a knowledge-based acquisition approach that provides better balance in the program by spreading out requirements and adding resources and time for development.The prime contract calls for the collection of drawing release data and statistical process control data; its award fee provides incentives for demonstrating increasing levels of design stability.



Comanche Program

Technology Maturity
Seven of the Comanche's eight critical technologies are considered mature. However, the radar cross-section technology, needed for low observability, requires additional development. The Army does not expect this technology will reach maturity until fiscal year 2005—1 year before the production decision.

Design Maturity
The Comanche program essentially attained design stability for the initial configuration of the aircraft. At the completion of the design review, 84 percent of the helicopter's engineering design drawings were complete and released to the manufacturer.

Prior to the 2002 program restructuring, integration of critical technologies was considered high risk, even though most of the technologies had demonstrated individual maturity. The restructuring adopted an evolutionary acquisition approach, realigned program requirements, added about $4.0 billion for additional testing, added time and testing capabilities, and adopted methods for improving contractor performance. The additional resources, coupled with fewer initial requirements, allowed the program to build more design knowledge before committing to production—thereby reducing risks. The tools used to gather and validate design knowledge are required by the contract, and targeted award fees provide additional incentives for building knowledge.

One remaining design risk is that development testing of a fully integrated Comanche will not take place until after the production decision. Discovering and correcting design problems during production will be much costlier than problems discovered during development.

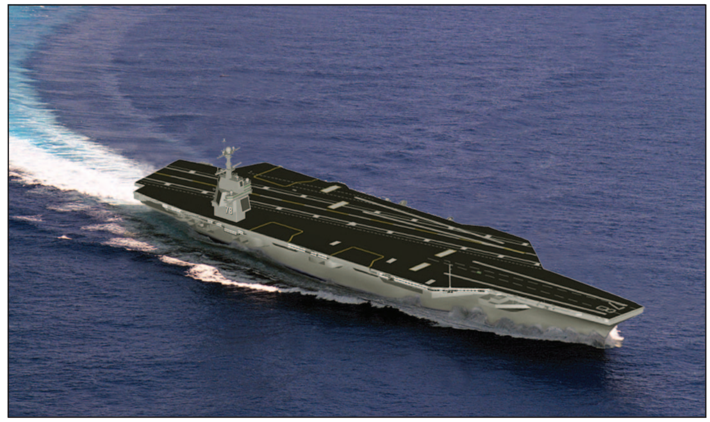
Production Maturity
The restructured Comanche program calls for collecting more knowledge about production processes and production maturity than we have seen on many programs. Specifically, the Army plans to collect information on control over the Comanche's production processes and reliability, and it has included these requirements in the Comanche contract. In addition, the contractor has established reliability growth plans and goals and has started conducting reliability growth testing. At this point, two risks for demonstrating production maturity remain: (1) it is not clear that all key aircraft characteristics will be identified by the critical design review and (2) the Army has not set a standard for what constitutes an acceptable level of production process control.

Program Office Comments
In commenting on a draft of this assessment, the program office generally concurred with the information presented in this report. It noted however that comparing the current program with the acquisition program baseline dated October 2002 would show essentially no variance.

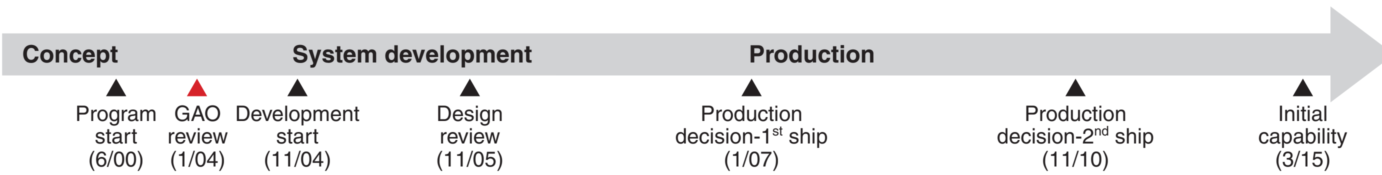
GAO Comments
While the program has established a new cost and performance baseline since the July 2000 decision to begin development, the comparison presented provides an accurate picture of change since that major decision. Although DOD may update its baseline for management purposes, our goal is to provide an aggregate or overall picture of the program's history.

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 will 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.



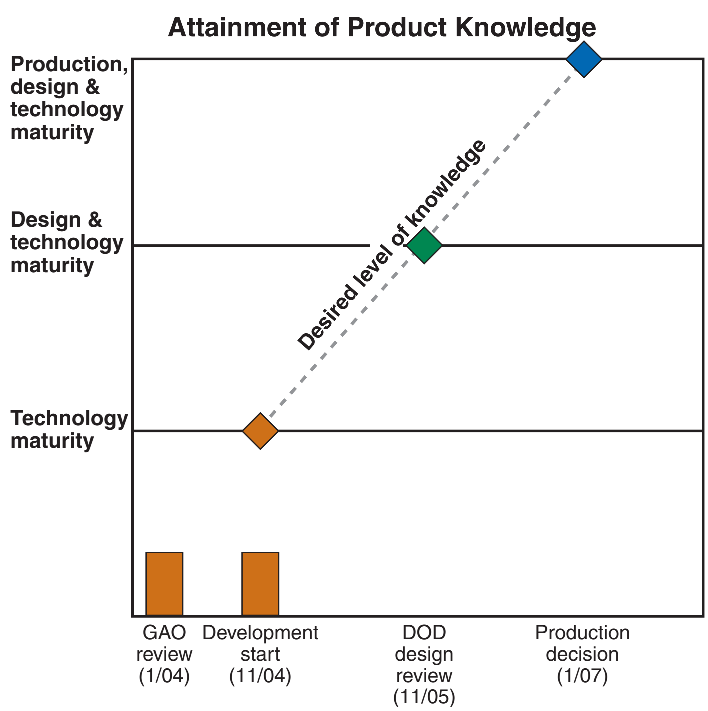
Program Essentials

Prime contractor: Northrop Grumman Newport News
Program office: Washington, D.C.
Funding needed to complete:
- R&D: $1,862.9 million
- Procurement: TBD
- Total funding: TBD
- Procurement quantity: 1

Program Performance (fiscal year 2004 dollars in millions)

	As of 06/2000	Latest 09/2003	Percent change
Research and development cost	$2,229.4	$3,031.3	36.0
Procurement cost	$0.0	$9,056.5	0.0
Total program cost	$2,229.4	$12,087.9	442.2
Program unit cost	**$0.000**	**$12,087.852**	**0.0**
Total quantities	0	1	0.0
Acquisition cycle time (months)	165	177	7.3

The CVN-21 is expected to enter system development in April 2004 with very 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 into the first ship. The accelerated technologies are at much lower levels of maturity. Program officials state that the extended construction and design period that ends in 2014 allows further time for technology development. Program officials established a risk reduction strategy that includes decision points for each technology's inclusion based on demonstrated maturity level. These decision points coincide with key design milestones and include mature backup technologies for all but two technologies.



CVN-21 Program

Technology Maturity

Program officials currently estimate that 3 of the 13 critical technologies will be mature by system development, and that 3 more will be approaching maturity. An additional seven will be at much lower levels of readiness. The technologies vary widely in maturity due to a mix of factors, including decisions by acquisition officials, standard practices in Navy shipbuilding, and feasibility of sea-based testing.

Of the six critical technologies identified at or just below recommended maturity levels by system development, all were a part of the original acquisition approach for the first ship. These technologies were well into development by December 2002 when the program was restructured and technologies were accelerated from the second ship into the first ship. For example, the original technologies included the reverse osmosis desalinization plant, critical to the functioning of the nuclear propulsion system as well as daily functions. Through a series of land- and sea-based tests, this technology has been brought to recommended maturity levels.

In contrast, technologies accelerated during the restructuring are at lower levels of maturity. For example, the advanced weapons elevator will exceed the current elevator load capacity by 70 percent or more while increasing sortie rates and decreasing operating costs. Development of this technology did not begin until February 2003, and it will not be fully mature by the start of system development.

Program officials stated that the risk associated with development of some CVN-21 technologies is manageable due to the nature of ship construction. Critical technologies, such as the radar systems and the advanced arresting gear, reside in the upper decks of the ship and are not slated for ship installation until late in the process.

Program officials stated that it is not possible to mature some systems to the best practices standard early in development. One such system is the electromagnetic aircraft launch system, a replacement for the current steam catapult system used to launch aircraft off carriers. This system has been in development since the late 1990s, but due to the size and complexity of the system it cannot be prototype tested aboard a surrogate ship. While land-based demonstrations of form, fit, and function are possible, a full operational environment is not reasonably achievable.

The program's risk reduction strategy defines a timeline for making decisions about a technology's maturity. For the majority of the technologies, a readiness review will occur in early fiscal year 2005. Other technologies, primarily those included in later stages of design, will be assessed later. If technologies are not ready for inclusion, fallback technologies will be used. The program has mature fallback technologies for all systems except nuclear propulsion and desalinization systems.

Other Program Issues

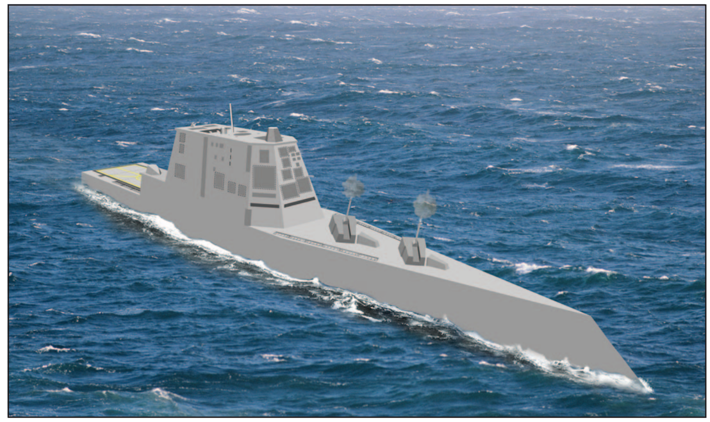
System development was delayed by the decision to restructure the program; however, the dates for construction start and commissioning the ship have not been moved. The date for delivering the ship to the fleet is driven by the decommissioning of the U.S.S. *Enterprise*, which will reach the end of its service life in 2014. This schedule compression raises the risk of costly redesign late in development.

Program Office Comments

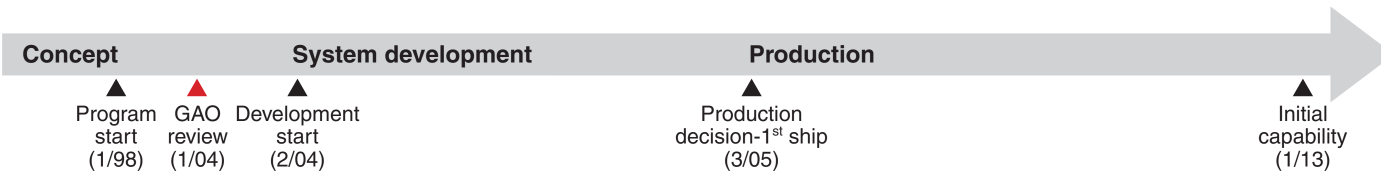
In commenting on a draft of this assessment, the program office emphasized that the CVN-21 program has established a technology development strategy to manage the risk associated with bringing new technologies into the design. Each new technology has a development timeline with identified decision points for evaluating technology maturity. These decision points are linked to key events in the platform design schedule and the technology development schedule. Program officials stated that if sufficient maturity has not been demonstrated at the decision points, an "off-ramp" can be selected to a fallback technology. Fallback plans identify existing, mature technologies that can be incorporated into the design within ship delivery schedule constraints. Program officials indicated that in some cases selection of an off ramp would result in a loss of projected operational capability, but at least equal current capability. Technologies that do not mature in time will continue development for follow-on ships.

DD(X) Destroyer

The Navy's DD(X) is a multimission surface combatant designed to provide advanced land attack capability in support of forces ashore and contribute to U.S. military dominance in littoral operations. In November 2001, the Navy restructured the DD(X) program to focus on developing and maturing a number of transformational technologies. These technologies will provide a baseline to support development of a range of future surface ships such as the future cruiser and the Littoral Combat Ship.



Source: U.S. Government.



Program Essentials

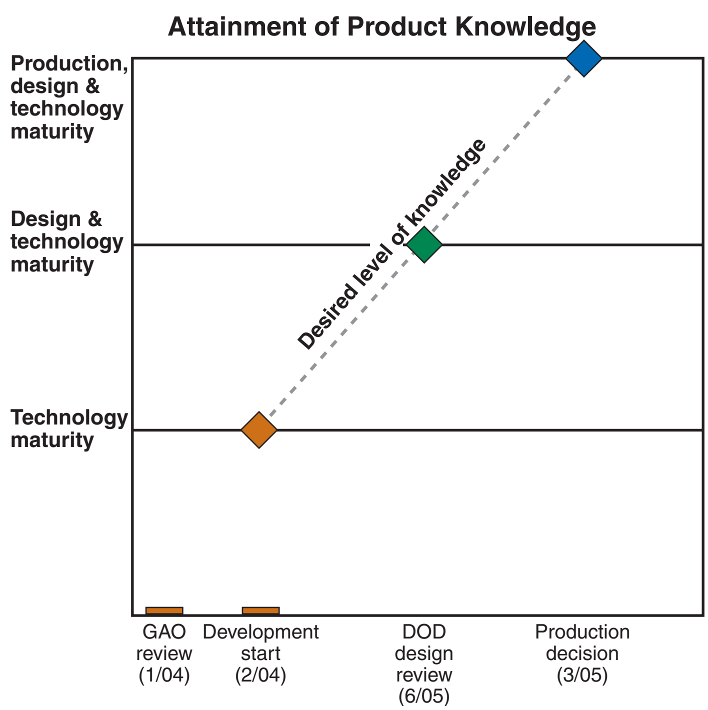
Prime contractor: Northrop Grumman Ship Systems
Program office: Washington, D.C.
Funding needed to complete:
- R&D: $7,452.1 million
- Procurement: TBD
- Total funding: TBD
- Procurement quantity: TBD

Program Performance (fiscal year 2004 dollars in millions)

	As of 01/1998	Latest 10/2003	Percent change
Research and development cost	$1,931.3	$10,046.6	420.2
Procurement cost	$0.0	$0.0	0.0
Total program cost	$1,931.3	$10,046.6	420.2
Program unit cost	**$0.000**	**$10,046.576**	**0.0**
Total quantities	0	1	0.0
Acquisition cycle time (months)	128	180	40.6

Costs increased due to changes in cost estimates, technology development programs, and program restructuring. Current estimate includes detailed design and construction of the lead ship.

DD(X) is scheduled to enter system development with none of its 12 critical technologies fully mature. The program is pursuing risk mitigation by constructing and testing engineering development models for its critical technologies. The acquisition strategy calls for engineering development model construction and testing concurrent with system design. Because of schedule slippage, only two models will be mature by the award of the lead ship construction contract, currently planned for September 2005. Backups are available for only 2 of the 12 technologies. Program progress has been hampered by changes in desired ship size and capabilities.



DD(X) Program

Technology Maturity

None of the 12 critical technologies for DD(X) are fully mature. The Navy does not anticipate any of these technologies reaching maturity prior to entering system development. At the time of the first ship production decision, the Navy expects to have only two critical technologies sufficiently tested to demonstrate maturity. Only two backup technologies exist, one for the integrated power system and one for the hull form. While the backup technology for the integrated power system is mature, the alternate hull form remains in development. If other critical technologies do not mature as planned, system redesign would occur.

The DD(X) Program Office is managing risk in part by constructing and testing engineering development models for each of the 12 critical technologies. The program's acquisition strategy scheduled these models to be fully built and tested concurrent with system design and completed before authorizing construction of the first ship. Current testing schedules call for the integrated power system, dual band radar suite, total ship computing environment, and peripheral vertical launching system to continue development beyond lead ship production decision.

A second element in the risk reduction strategy is "design budgeting." According to the program manager, this approach consists of designing the requirements for technologies with a margin for growth. The DD(X) program allows for a 10 percent margin to account for necessary increases in size, weight, or manpower discovered through testing of the engineering development models. If the 10 percent margin is exceeded, system redesign would occur.

Modifications to ship size and capabilities affected the progress of the technology maturation process. In June 2003, the weight of the ship was reduced, prompting redesign of the advanced gun system and hull form engineering development models. Multiple reevaluations of radar characteristics contributed to a delay in the development of the dual band radar engineering development model.

Other Program Issues

The DD(X) acquisition strategy focuses on developing and maturing technologies that could be leveraged across multiple ship classes. If DD(X) critical technologies do not reach maturity or are delayed, risks will increase for other programs in development. For example, the delay associated with the DD(X) dual band radar suite has already affected the CVN 77 Nimitz class aircraft carrier program. As a result, the aircraft carrier was forced to use a legacy radar system, leading to costly redesign and rework.

Program Office Comments

In commenting on a draft of this analysis, the program office stated that the ability of DD(X) to deliver revolutionary capabilities with reduced crew necessitates some element of development and production risk. Program officials expect that the spiral development approach adopted in 2001, combined with robust testing of the engineering development models, will mitigate that risk. Officials indicated that, since the 2002 contract award, the only significant schedule change was due to dual band radar changes.

The program office also stated that the time required to design and build a ship makes the process unique from other weapon systems. DOD policy states that ship technologies must be mature in time for installation, and the program office stated that all DD(X) engineering development models will meet this requirement. At design review, the program expects that most engineering development models will be nearing maturity, and that design budgeting will enable incorporation of changes.

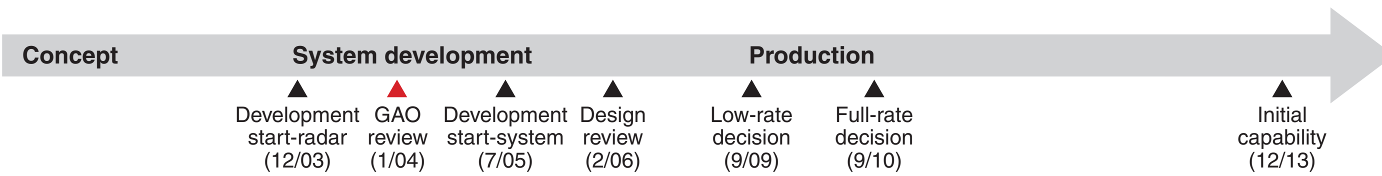
GAO Comments

The program will be integrating technologies into a ship-level system design at the same time that it is maturing individual technologies. Should any of these innovative technologies encounter challenges that cannot be accommodated by design budgeting, redesign of other technologies and of the integrated system may be needed. Redesign would likely result in additional costs and schedule delays as well as affect the planned installation schedule.

E-10A Multi-Sensor Command and Control Aircraft (E-10A)

The Air Force's E-10A aircraft (formerly known as the MC2A) is planned to provide the next generation of airborne surface surveillance capability and focused air surveillance for cruise missile defense. It will consist of a modified, commercial Boeing 767 airframe, an active electronic scanned array radar, and a battle management, command and control computer mission subsystem. Development of the radar and funding of the first airframe have begun. We assessed only the radar.

Source: The Boeing Company.



Program Essentials

Prime contractor: Northrop Grumman (prime)/Boeing/Raytheon
Program office: Hanscom Air Force Base, Mass.
Funding to complete through 2009:
- R&D: $1,907.9 million
- Procurement: $1,311.2 million
- Total funding: $3,219.1 million
- Procurement quantity: 2

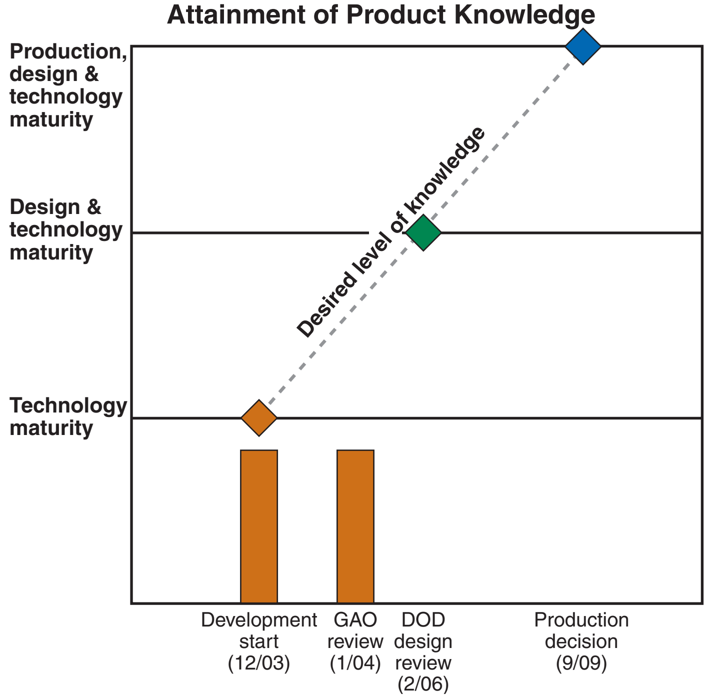
Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 11/2003	Percent change
Research and development cost	NA	$2,245.0	0.0
Procurement cost	NA	$1,311.2	0.0
Total program cost	NA	$3,556.2	0.0
Program unit cost	**NA**	**$1,185.400**	**0.0**
Total quantities	NA	3	0.0
Acquisition cycle time (months)	NA	101	NA

The latest costs reflect all costs from the program's inception through fiscal year 2009, and are for the entire E-10A system.

Only the radar subsystem of the E-10A aircraft has entered system development. Six of the radar's nine critical technologies are fully mature. The remaining three are nearing full maturity, but they are not expected to reach full maturity until the first E-10A flight in 2009. The entire E-10A weapon system is scheduled to enter system development in July 2005. At that time, the program plans to integrate the radar with the airframe and the battle management, command and control computer mission subsystem. The Air Force has identified ongoing changes to requirements and software development as high risks. The program is projected to provide initial operational capability by 2013, 1 year later than required, due to a fiscal year 2003 congressional funding reduction.

Attainment of Product Knowledge



E-10A Program

Technology Maturity

At the start of the radar's product development in December 2003, six of the nine critical technologies were mature and had been demonstrated in an operational environment. The remaining three technologies are nearing full maturity, but they are not expected to reach full maturity until the first E-10A flight in 2009.

Design Maturity

We did not assess the design maturity of the E-10A radar as the number of releasable drawings is not yet available.

Other Program Issues

The development of the entire E-10A platform includes the radar, the Boeing 767 airframe, and the battle management, command and control computer mission subsystem and is scheduled to begin in July 2005. At that time, the computer mission subsystem must achieve software and hardware maturity to demonstrate the machine-to-machine communications capability needed to operate with legacy command and control systems. The radar and antenna need to be incorporated into the Boeing 767, as do other capabilities, such as adding air-refueling, hardening the airframe hull against electro-magnetic interference, strengthening the cabin floor, and increasing the onboard electric power generation. Hosting the radar on the Boeing 767 involves incorporating an open systems architecture and interfaces that have yet to be designed.

The program office identified a number of high risks in the program. For example, design changes to the platform may be needed to address weight and drag issues, which can affect range and time on station. Ongoing reviews of the operational requirements, and changes to the requirements, may also affect system function and design. In addition, software development is considered a high risk because of the large number of lines of code, range of applications needed, and changing requirements.

The Office of the Secretary of Defense recently directed that the Air Force delay the start of development for the E-10A from July 2004 to July 2005. This was done to better align program reviews with the delivery of the test bed aircraft in December 2005 and to provide sufficient time to complete a study on ground-moving target indicator capability.

The program office implemented a spiral development approach to incrementally deliver E-10A capability. Program officials stated that the E-10A will reach its initial capability in 2013, 1 year later than the operational need date of 2012, due to a $343 million congressional cut in fiscal year 2003 program funding.

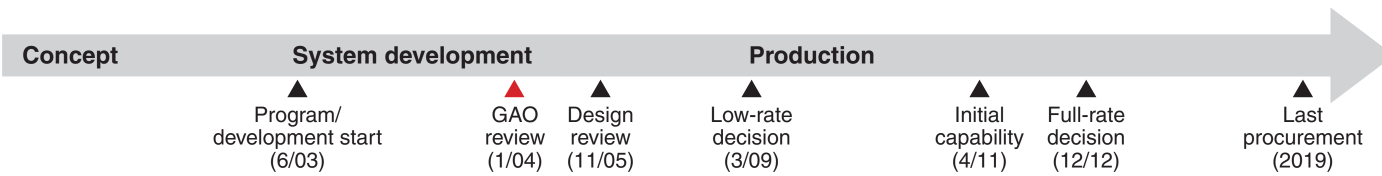
Program Office Comments

In commenting on a draft of this assessment, program officials stated that the E-10A program is on track to provide the initial capability of the next-generation airborne surface surveillance, and is focused on surveillance for cruise missile defense, to the warfighter by 2013 in accordance with the current program schedule and funding.

E-2 Advanced Hawkeye (E-2 AHE)

The Navy's E-2 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 acquired for the E-2C Hawkeye platform since its first flight in 1971. The E-2 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 Officer, Tactical Aircraft Programs (PMA-231).



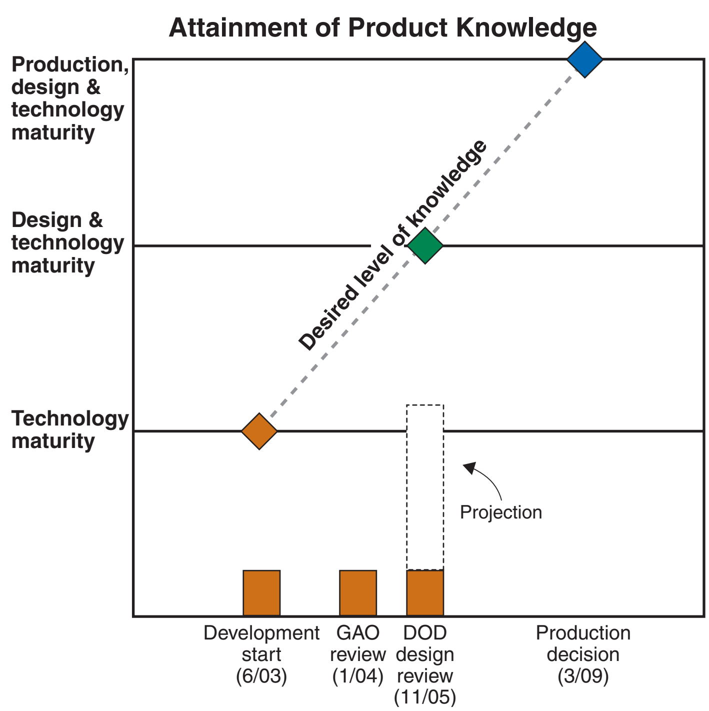
Program Essentials

Prime contractor: Northrop Grumman Corp.
Program office: Patuxent River, Md.
Funding needed to complete:
- R&D: $3,123.3 million
- Procurement: $9,483.2 million
- Total funding: $12,606.5 million
- Procurement quantity: 69

Program Performance (fiscal year 2004 dollars in millions)

	As of 06/2003	Latest 08/2003	Percent change
Research and development cost	$3,311.6	$3,308.8	-0.1
Procurement cost	$9,483.2	$9,483.2	0.0
Total program cost	$12,794.9	$12,792.0	0.0
Program unit cost	**$170.598**	**$170.560**	**0.0**
Total quantities	75	75	0.0
Acquisition cycle time (months)	95	94	-1.1

The E-2 AHE program entered system development in June 2003 without demonstrating that its four critical technologies had reached full maturity. Program officials do not expect to achieve maturity on those critical technologies until at least a third of the way through product development. The program office plans to have the majority of drawings completed by the time of design review in November 2005. However, until the technologies are mature, the potential for design changes remains.



E-2 AHE Program

Technology Maturity

None of the E-2 AHE's four critical technologies are fully mature. The four critical technologies are the rotodome antenna, the Silicon Carbide-based transistor for the Power Amplifier Module to support E-2 UHF radio operations, the Multi-channel Rotary Coupler for the antenna, and the Space Time Adaptive Processing algorithms and associated processor. The program expects to have these technologies matured after critical design review but before production, which is scheduled to start in March 2009.

More mature backup technologies exist for three of those technologies (the rotodome antenna, the Silicon Carbide-based transistor, and the Multi-channel Rotary Coupler) and are currently being flown on a larger test platform. However, use of the backup technologies would result in degraded system performance or reduced ability to accommodate future system growth due to size and weight constraints. While there is no backup for the fourth technology (Space Time Adaptive Processing algorithms and associated processor), the program office is confident that the technology will operate well on the test aircraft in 2005.

Design Maturity

While none of the engineering drawings are complete, program officials project that they will have 81 percent completed by the time of critical design review in November 2005 and that 100 percent will be completed by the time of the production decision in March 2009. However, the technology maturation process may lead to more design changes.

Program Office Comments

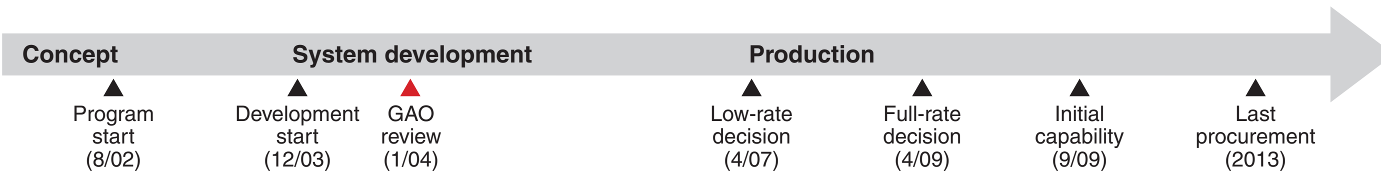
In commenting on a draft of this assessment, the program office stated that the AHE program entered system development and demonstration after 6 years of research development and 18 months of presystem development work. Program officials also stated that in preparation for entry into system development a technology readiness assessment was performed using industry, academic, and government experts and that the results of that assessment were approved in accordance with DOD's acquisition guidance. The program office noted that the maturity of the technologies examined in that assessment was primarily based on demonstrations conducted in 1997 and 1999 and did not include recent accomplishments, including AHE test-bed flights conducted through the summer of 2003.

The next AHE technology readiness assessment is to be performed prior to the production decision for the system in fiscal year 2008, and the program office anticipates that the critical technologies will be mature at that time. In addition, program officials noted that a mature risk process, with mitigation plans, exists for the entire AHE program, including critical technologies, which focuses on risks associated to operational requirements.

EA-18G Growler (EA-18G)

The Navy's EA-18G is an electronic attack aircraft designed to jam enemy radar and communications and conduct electronic warfare as part of a battle group. The program was approved as a replacement for the EA-6B aircraft, and will integrate its electronic warfare technology into the F/A-18F platform. Because of the heavy use of the aging EA-6B aircraft, a large number are being retired due to wear. To prevent a gap in electronic war-fighting capabilities, DOD intends to begin fielding the EA-18G in 2009.

Source: F-18 Program Office.



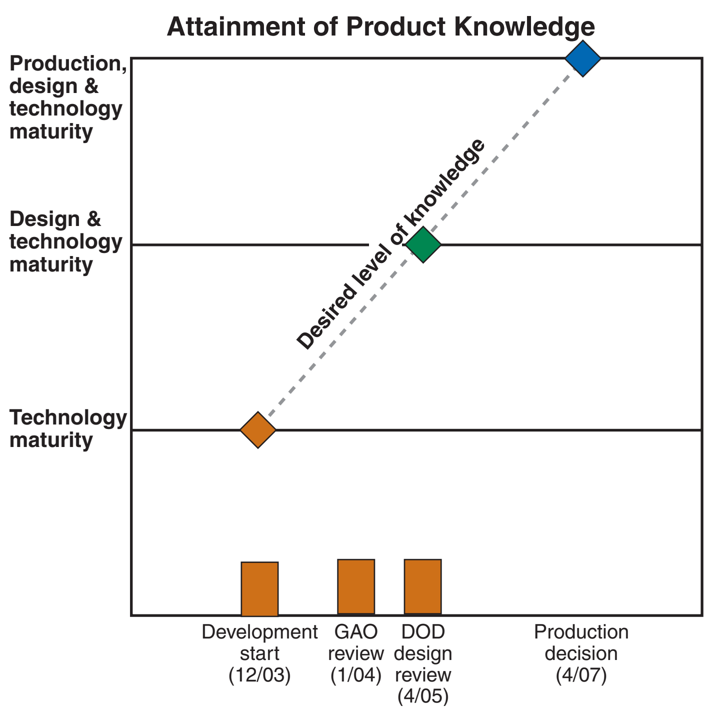
Program Essentials

Prime contractor: Boeing
Program office: Patuxent River, Md.
Funding needed to complete:
- R&D: $1,632.2 million
- Procurement: $6,030.5 million
- Total funding: $7,662.7 million
- Procurement quantity: 90

Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 12/2003	Percent change
Research and development cost	NA	$1,632.1	0.0
Procurement cost	NA	$6,030.5	0.0
Total program cost	NA	$7,662.6	0.0
Program unit cost	**NA**	**$85.140**	**0.0**
Total quantities	NA	90	0.0
Acquisition cycle time (months)	NA	68	NA

The EA-18G entered system development without demonstrating that its five critical technologies had reached full maturity. Three technologies were very close to maturity and two technologies require substantial adjustments. In addition to the mechanical challenges of integration, the program also faces risks with software integration. The EA-18G will rely on technological upgrades developed for the EA-6B, which could increase program risk.



EA-18G Program

Technology Maturity

None of EA-18G's five critical technologies are fully mature. While they are similar to the mature technologies on the EA-6B and the F/A-18F, integrating the technologies into the EA-18G requires significant modification. Three critical technologies, the ALQ-99 pods, the F/A-18F platform, and the tactical terminal system, are approaching full maturity. The remaining two technologies, the receiver system and the communications countermeasures set, are not mature.

Both of the less mature technologies, the receiver system and the communications countermeasures set, require substantial modification to operate on the EA-18G. The receiver system will be similar to the system on the EA-6B, with adjustments to allow it to fit onboard the F/A-18F platform. Several of the receiver's components, such as the antenna preselectors, will also need to be upgraded, mainly because some have become obsolete. The communications countermeasures set on the EA-6B is no longer in production, and a contractor will be selected to develop a new set for the EA-18G. While the new set will be based on existing technology, there is additional risk to the program until the new set is produced and demonstrated to work in the EA-18G.

The electronic warfare equipment on the EA-18G will be subject to a more severe operating environment than on the EA-6B. Advanced technologies will be needed to counter the higher levels of vibration.

Other Program Issues

The EA-18G program plans to build one-third of its aircraft during low-rate initial production due to the need to begin replacing retiring EA-6Bs by 2009. Any problems that arise during production could result in costly modifications to the already produced aircraft.

Additionally, the increased weight and vibration caused by the electronic warfare equipment added to the F/A-18F platform may limit the life span of the aircraft. Although the program office asserts that the design will meet life span requirements, it plans to conduct additional testing and design work to further extend the life span of the aircraft.

Program Office Comments

The EA-18G weapon system integrates proven EA-6B Airborne Electronic Attack (AEA) systems onto the combat proven F/A-18F platform. Due to the maturity of the systems, the EA-18G program risk is significantly less than a new weapon system development. To date, the program has not identified any major technical inabilities to achieving the current design approach within cost and schedule constraints. Program officials believe that all five critical items are fully mature, including the ALQ-99 pods that have been in existence for 30 years, and the F/A-18F platform and tactical terminal, which are both in production for the Navy.

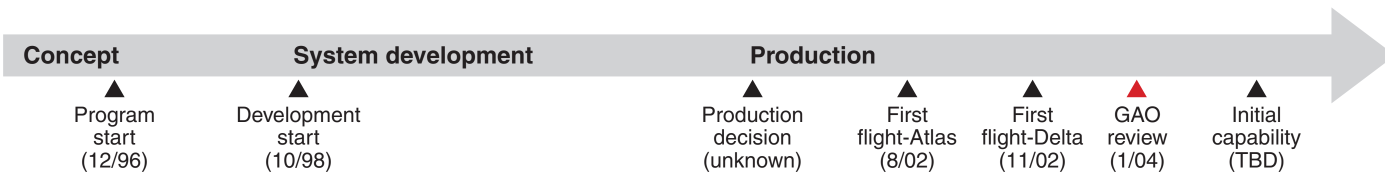
GAO Comments

While the ALQ-99 pods have existed for 30 years, they are being physically modified to be compatible with the F/A-18F pylons and will have a pod interface unit added to them for communications with the F/A-18F platform. The F/A-18F platform is being modified to support the installation of the AEA suite and to increase auxiliary memory. The tactical terminal will be modified to fit inside the F/A-18F platform and will have a new antenna. Because of these changes to form and fit, these systems, while approaching full maturity, are not yet fully mature.

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

The Air Force's EELV program is an industry partnership to acquire commercial satellite launch services from two competitive families of launch vehicles—Atlas V and Delta IV. The program's goal is to meet the government's launch requirements while reducing the life-cycle cost of space launches by at least 25 percent over existing systems. Different types of lift vehicles may be used, depending on the particular mission. We assessed both the Atlas V and the Delta IV.

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



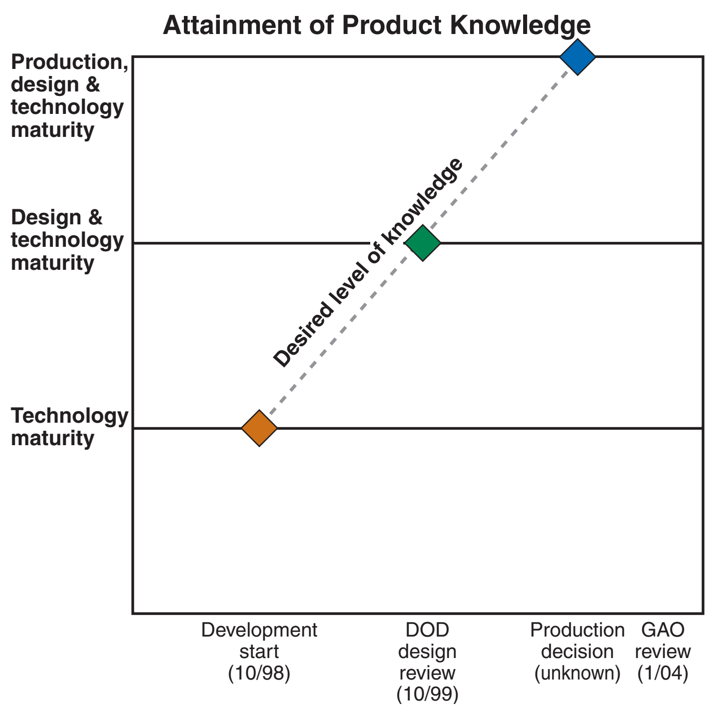
Program Essentials

Prime contractor: Lockheed Martin & Boeing Launch Services
Program office: El Segundo, Calif.
Funding needed to complete:
R&D: $45.3 million
Procurement: $15,854.7 million
Total funding: $15,899.9 million
Procurement quantity: 173

Program Performance (fiscal year 2004 dollars in millions)

	As of 10/1998	Latest 09/2003	Percent change
Research and development cost	$1,509.4	$1,736.2	15.0
Procurement cost	$13,221.7	$16,707.3	26.4
Total program cost	$14,731.1	$18,443.5	25.2
Program unit cost	**$81.387**	**$101.338**	**24.5**
Total quantities	181	182	0.6
Acquisition cycle time (months)	TBD	TBD	TBD

Implicit in the government's decision to purchase launch services, is the assumption that the Delta IV and Atlas V launch vehicles are capable of carrying satellite payloads. The program office does not believe it needs formal information on EELV's technology, design, and production maturity because it is buying the service. It does have access to this data, however. The core launch vehicles are mature, and since August 2002, there have been six successful launches—two government and four commercial. However, the heavy lift vehicle (HLV) has yet to complete production and fly a demonstration mission.



EELV Program

Technology Maturity

We could not assess the technology maturity of the EELV because the Air Force has not formally contracted for information on the technology maturity of the EELV launchers from its contractors. Program officials state that they ensure that all government missions are on track for their currently scheduled launch dates through daily insight and interaction in contractors' development, engineering, manufacturing, and operations processes.

Design Maturity

We could not assess the design maturity of the EELV because the Air Force was not able to provide information needed to conduct this assessment.

Production Maturity

We could not assess the production maturity of the EELV because the Air Force was not able to provide information needed to conduct this assessment.

Other Program Issues

Initial plans for the EELV program projected a much more robust commercial launch market. However, the decline in the commercial launch market since the late 1990s significantly reduced the anticipated number of Atlas V and Delta IV launches, making the government the primary customer for both launch vehicles. This reduction, in turn, caused anticipated prices for government launch services to increase significantly. According to the Air Force, EELV production rates vary and depend on the overall condition of the launch market. Contractors do not begin producing a launch vehicle until they receive an order for a launch service—usually about 2 years before launch.

The EELV program has recently experienced schedule and program cost changes. The program milestone schedule has slipped more than 6 months for the HLV demonstration mission and first operation flights. According to the Air Force, the delay occurred because of other launch priorities, slips in launch dates of the first three Delta IV missions, and modifications to the HLV launch pad.

A requirement to maintain two viable launch contractors over the next 5 years and efforts to improve government oversight have contributed to a $539-million increase in program costs. Other factors that contributed to the cost increase included an increase in launch price due to reallocating missions among the EELV contractors, an anticipated award of four additional missions, increases in satellite weight growth, and increases in support costs for a West Coast launch pad.

Although the EELV concept of launch vehicle families emphasizes commonality of hardware and infrastructure, EELV program officials are currently addressing technical risks. Both Delta IV and Atlas V use versions of the RL-10 upper stage engine, meaning an engine flaw could ground both vehicles. Until production of the Russian made RD-180 propulsion technology starts in the United States, the Atlas will continue to rely on this engine.

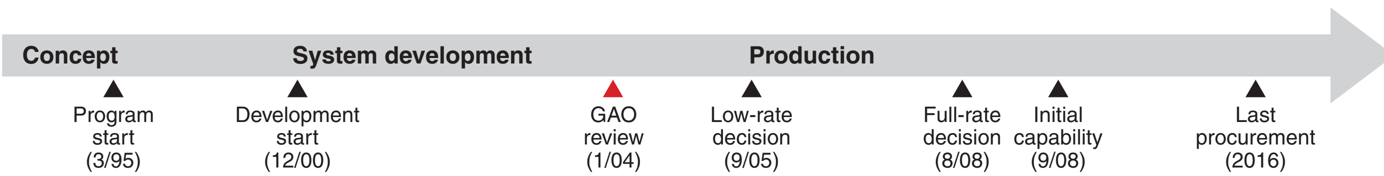
Program Office Comments

In commenting on a draft of this assessment, the program office generally concurred with our assessment. It acknowledged that it did not contract for technology, design, or production maturity deliverables, but daily government insight, interaction, and access to contractor data ensure readiness. Also, cost and schedule changes primarily resulted from a downturn in the commercial market and the addition of funding to maintain two viable launch competitors. The anticipated number of launches decreased significantly, increasing prices for government launches. The Delta IV HLV demonstration slipped; however, officials said they are ready to provide required launch services.

Expeditionary Fighting Vehicle (EFV)

The Marine Corps' EFV (formerly called the Advanced Amphibious Assault Vehicle) is designed to transport troops from ships off shore to their inland destinations at higher speeds and from farther distances than the existing AAV-7. It is designed to be more mobile, lethal, reliable, and effective in all weather conditions. EFV will have two variants—a troop carrier for 17 Marines and a command vehicle to manage combat operations in the field. We assessed both variants.

Source: General Dynamics Amphibious Systems.



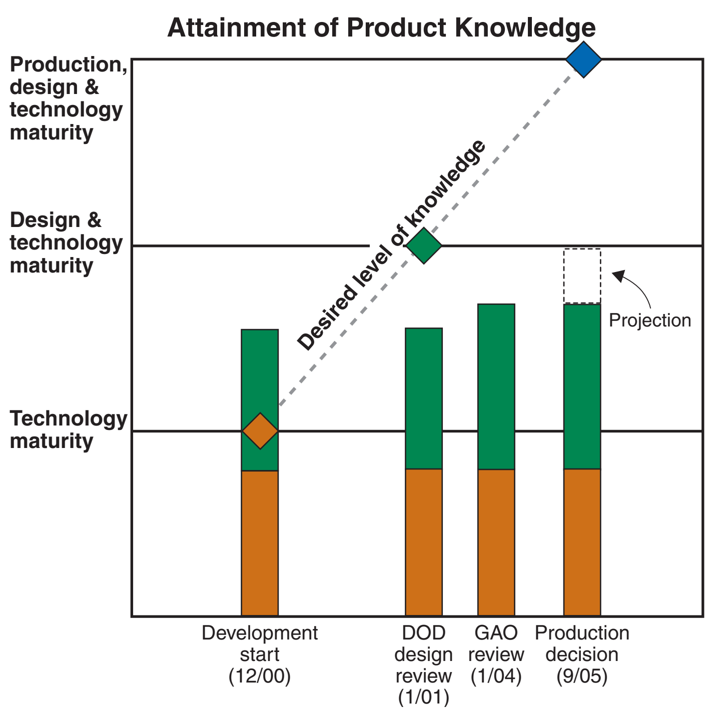
Program Essentials

Prime contractor: General Dynamics
Program office: Woodbridge, Va.
Funding needed to complete:
- R&D: $882.9 million
- Procurement: $7,378.4 million
- Total funding: $8,306.2 million
- Procurement quantity: 1,012

Program Performance (fiscal year 2004 dollars in millions)

	As of 12/2000	Latest 09/2003	Percent change
Research and development cost	$1,400.8	$1,966.1	40.4
Procurement cost	$6,282.3	$7,395.3	17.7
Total program cost	$7,763.7	$9,436.0	21.5
Program unit cost	**$7.574**	**$9.206**	**21.5**
Total quantities	1,025	1,025	0.0
Acquisition cycle time (months)	138	162	17.4

EFV demonstrated most technology and design knowledge at critical junctures in the program. At the start of the program, all but one of the critical technologies were mature. The design was close to meeting best practice standards at the design review, signifying the design was stable. Early development of fully functional prototypes and other design practices facilitated design stability. However, the remaining technology has not matured as expected, which may lead to some redesign. Also, the demonstration of production maturity remains a concern because the program does not plan to use statistical process controls to achieve quality. The EFV production decision is not scheduled until September 2005. Remaining efforts include developmental, operational, and reliability testing.



EFV Program

Technology Maturity

Four of EFV's five critical technologies are mature. The remaining technology, the moving map navigation technology, is not expected to reach maturity until the summer of 2004. This is a 1-year delay from what was reported last year on the EFV program. The moving map navigation is to provide situational awareness. As of November 2003 the technology had been demonstrated in a high fidelity laboratory environment on representative EFV system hardware. By next year, it should be demonstrated in an operational environment.

Design Maturity

The EFV has released nearly all of its drawings for the development prototype currently being manufactured. At the time of the critical design review in 2001, 77 percent of the drawings had been released, signifying the design was stable. After building the first seven development prototypes, the program identified changes that would affect about 10 percent of the drawings. Program officials said the changes to the drawings are mostly to attain better manufacturing efficiencies in producing the EFV and will be incorporated into the last two of the nine development prototypes. Program officials stated they will have additional design reviews prior to starting low-rate and full-rate production and that additional changes may result from ongoing development testing. Finally, until the moving map technology has been demonstrated and incorporated into the EFV design, the potential exists for additional design changes.

Within the last year, the program delayed the start of developmental testing by 3 months to fix defects in test vehicles. Based on lessons learned earlier in the program, the contractor put the initial EFV test prototypes through a short shakedown period before sending them to the developmental test location. The shakedown was intended to identify problems that could affect EFV availability during testing to avoid unnecessary increases in the testing costs. Also, reliability testing remains to be done.

Production Maturity

The program expects a low-rate production decision in September 2005, but does not require the contractor to use statistical process controls to ensure its critical processes are producing high quality and reliable products. Instead, the program has directed the contractor to develop a production readiness plan to ensure its critical processes are in control. The plan consists primarily of collecting postproduction quality data on items produced.

Because the final EFV production facility is not ready, the contractor is using the planned manufacturing processes to build prototypes at the development facility. This will provide verification of these manufacturing processes. However, when production moves to the new facility, processes will need to be validated again to ensure they work as expected. Furthermore, skills gained by staff working in the development facility may be lost if different people are hired at the production facility.

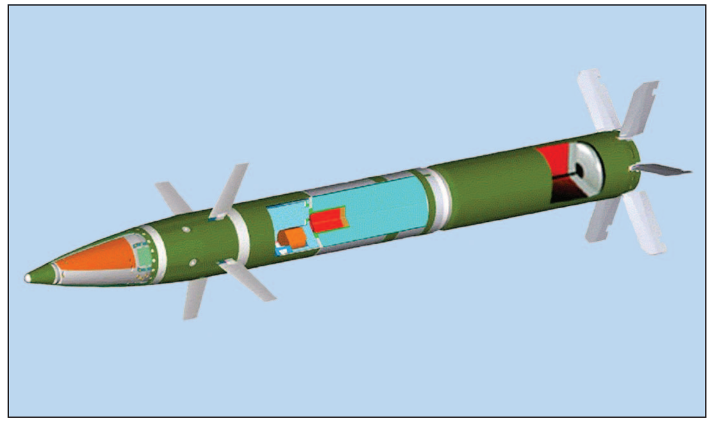
Program Office Comments

In commenting on a draft of this assessment, the program office stated that the acquisition plan is based on four design, build, and test iterations of EFV to mature the design and to prove its readiness for production and operation. The second iteration is currently underway as part of the system development and demonstration (SDD) phase of the program. The improvements from the first-generation prototypes will be demonstrated during extensive testing of the second generation of SDD vehicles. This testing began during the third quarter of fiscal year 2003 and will continue through a comprehensive operational assessment in fiscal year 2005.

General Dynamics is working toward certification to the International Organization for Standardization (ISO) 9001:2000 quality management standard. Various quality assurance methods are being implemented to meet the ISO standard. Statistical process control is one of the approaches to be used where applicable during low-rate and full-rate production.

Extended Range Guided Munition (ERGM)

The Navy's ERGM is a rocket-assisted projectile that is fired from a gun aboard ships. It can be guided to targets on land at ranges of between about 15 and 50 nautical miles to provide fire support for ground troops. ERGM is expected to offer increased range and accuracy compared to the Navy's current gun range of 13 nautical miles. ERGM requires modifications to existing 5-inch guns, a new munitions-handling system (magazine), and a new fire control system. We assessed the projectile only.



Source: Naval Surface Fire Support Program Office.

Concept | System development | Production

- Program/development start (7/96)
- Design review (5/03)
- GAO review (1/04)
- Low-rate decision (4/05)
- Full-rate decision (5/06)
- Initial capability (9/06)

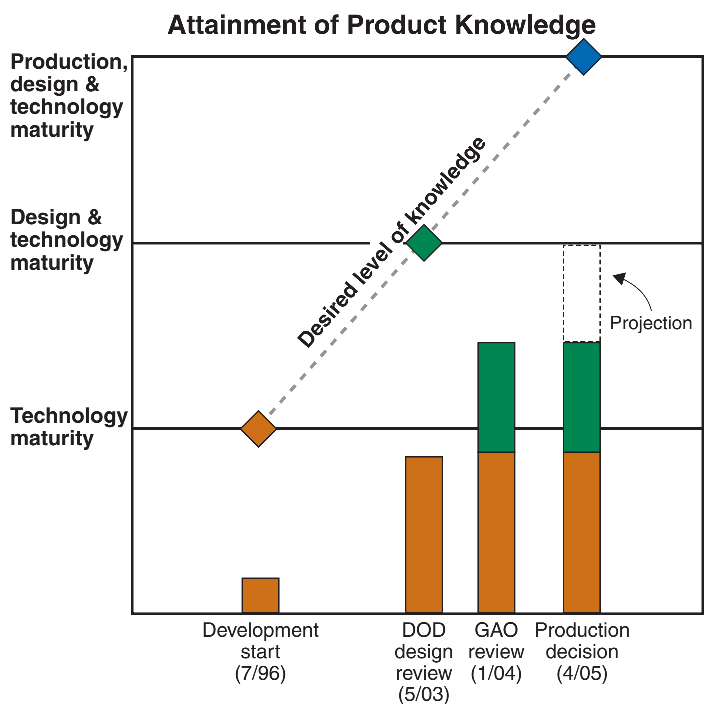
Program Essentials

Prime contractor: Raytheon
Program office: Washington, D.C.
Funding needed to complete:
R&D: $50.8 million
Procurement: $156.8 million
Total funding: $207.6 million
Procurement quantity: 3,055

Program Performance (fiscal year 2004 dollars in millions)

	As of 04/1997	Latest 12/2003	Percent change
Research and development cost	$77.6	$322.7	315.8
Procurement cost	$306.7	$185.9	-39.4
Total program cost	$384.3	$508.6	32.4
Program unit cost	**$0.045**	**$0.162**	**261.8**
Total quantities	8,570	3,135	-63.4
Acquisition cycle time (months)	49	121	146.9

The ERGM program began development with very few of its critical technologies mature, and while progress has been made, program officials do not expect to achieve maturity on all critical technologies until at least February 2004. No production representative engineering drawings were released to manufacturing by the design review; however, over half of these drawings have since been released. The program office expects to have a complete and updated drawing package by October 2004. Finally, due to several test failures, the program did not meet a Navy deadline that required successful completion of two land-based flight tests by November 2003. The Navy is conducting an independent assessment of the program's readiness to proceed with further flight-testing. The Navy has also issued a solicitation for alternative precision-guided munition concepts that could offer cost savings.



ERGM Program

Technology Maturity

Fifteen of ERGM's 20 critical technologies have demonstrated technological maturity. The remaining 5 technologies are approaching maturity, and program officials expect that all 20 critical technologies will be demonstrated in an operational environment by February 2004, almost 8 years after the start of system development. Four of these five technologies are related to the unitary warhead design change, which was made in January 2002. In our May 2003 assessment, the program office projected that these technologies would be mature by the end of 2003. However, a series of flight test failures prevented the program from demonstrating these technologies as projected.

Design Maturity

The program released approximately 54 percent of drawings, and the program office plans to have all production representative drawings complete by October 2004, over 1 year after the design review. This updated and mature drawing package will reflect knowledge gained from 18 flight tests and qualification tests and will be used to build production representative operational test rounds.

At the May 2003 design review, none of ERGM's 128 production representative engineering drawings had been released. Instead, the program conducted this review with less mature drawings and used them to validate the design of the development test rounds.

According to program officials, seemingly minor design and quality assurance problems have been responsible for the recent test failures. For example, one of the causes of a June 2003 test failure was a design flaw in the rocket motor's igniter, a .012-inch gap between two parts, which caused it to fall out after gun launch. This problem was addressed, and the igniter functioned properly during three later flight tests. Another critical test was delayed when excessive paint on the round made it slightly too large to fit in the gun barrel. As a result of these test issues and others, the program office failed to meet a Navy deadline that required the successful completion of two land-based flight tests by November 2003. In February 2004, a component-level flight test of the rocket motor was also unsuccessful. As a result, ERGM guided flight tests, scheduled for February 2004, have been postponed. An independent failure investigation, which will determine the program's readiness to proceed with further guided flight tests, has been initiated.

Production Maturity

Since the ERGM program will not begin to build production representative rounds until October 2004, Raytheon has not started to collect information on production process maturity. The manufacturing plan states the contractor will identify key product characteristics and then determine how to implement statistical process control. However, it is not clear when this will occur.

Other Program Issues

Future program costs are not accurately reflected in the latest program cost estimate because the estimate is based on a much lower production quantity than is contained in current program documents and the Navy has yet to establish a firm ERGM inventory requirement. A new program baseline with revised cost and quantity information will not be available until at least March 2004.

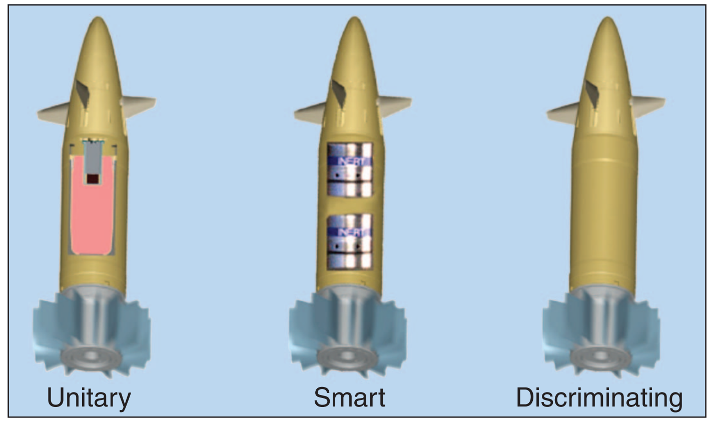
In October 2003, the Navy issued a solicitation for alternative precision-guided munition concepts that could be a complement or competitor to ERGM. In particular, the Navy is concerned about the unit cost of the ERGM round and is looking to develop alternatives that could offer cost savings. The Navy plans to spend $35 million in fiscal years 2004 and 2005 to pursue a technology demonstration of other extended range munition concepts by September 2005.

Program Office Comments

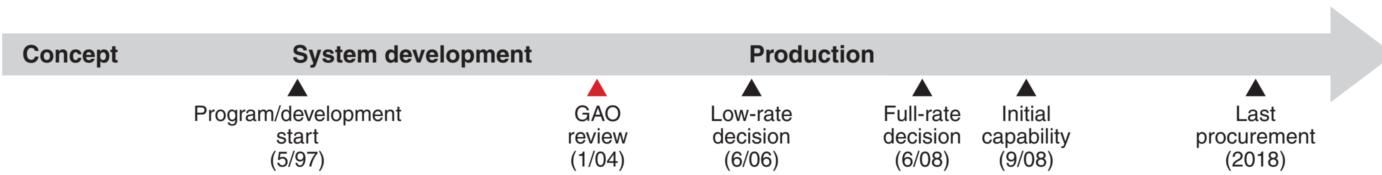
In commenting on a draft of this assessment, the program office noted that it is investigating a number of options for restructuring the ERGM program to address technical, budget, and schedule issues. The program office also provided separate technical comments, which were incorporated as appropriate.

Excalibur Precision Guided Extended Range Artillery Projectile

The Army's Excalibur is a family of global positioning system-based, fire-and-forget, 155-mm cannon artillery precision munitions. 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. It would allow the Future Combat Systems' non-line-of-sight cannon to fire from farther away and defeat threats more quickly.



Source: U.S. Army.



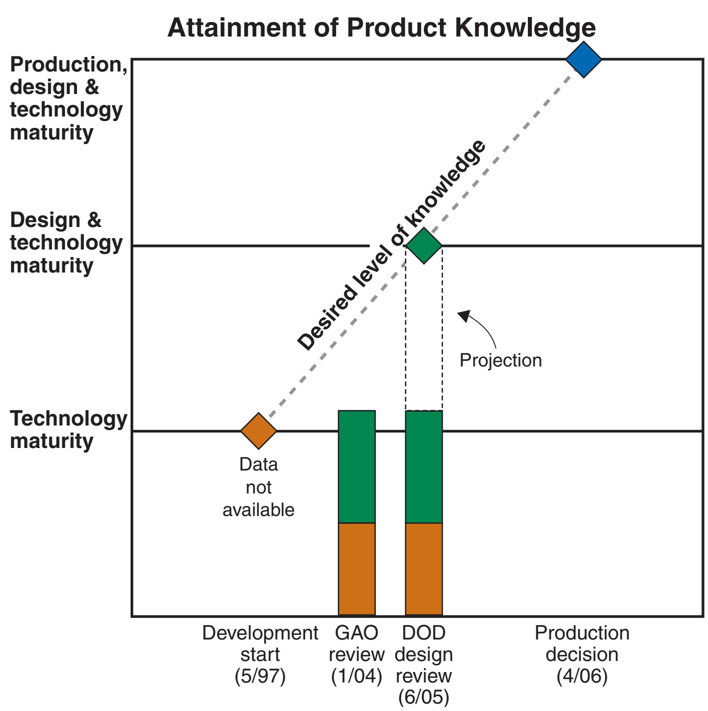
Program Essentials

Prime contractor: Raytheon
Program office: Picatinny Arsenal, N.J.
Funding needed to complete:
- R&D: $425.4 million
- Procurement: $3,407.4 million
- Total funding: $3,832.8 million
- Procurement quantity: 76,408

Program Performance (fiscal year 2004 dollars in millions)

	As of 05/1997	Latest 09/2003	Percent change
Research and development cost	$59.6	$650.3	991.9
Procurement cost	$668.0	$3,407.4	410.1
Total program cost	$727.6	$4,057.8	457.7
Program unit cost	**$0.004**	**$0.053**	**1,354.7**
Total quantities	200,000	76,677	-61.7
Acquisition cycle time (months)	160	136	-15.0

The Excalibur program's critical technologies are not fully mature, even though product development began over 6 years ago. Currently, about one-half of the drawings are at a level that could be released to manufacturing. Program officials expect to have technological maturity and design stability by the design review in 2005. The program has encountered a number of challenges since development began, including a decrease in planned quantities, a relocation of the contractor's plant, early limited funding, technical problems, and changes in program requirements. This past year, it completed a major restructuring by merging with the Trajectory Correctable Munition program.



Excalibur Program

Technology Maturity

None of the Excalibur's three critical technologies—the guidance control system, the airframe, or the warhead—are fully mature. According to program officials, all three have been demonstrated in a relevant environment and are expected to reach full maturity before the design review in June 2005. The warhead was not considered a critical technology in 1997 because the Excalibur design called for a warhead that was under production for other munitions. At the Army's direction, the program has undertaken development of a different warhead that is undergoing testing.

Design Maturity

Currently, 55 percent of the Excalibur's engineering drawings are releasable to manufacturing. The program office plans to have all drawings complete by the design review in June 2005. The program recently successfully conducted a preliminary design review to verify that the Excalibur's initial design has the potential to satisfy system requirements.

Other Program Issues

The program has gone through many changes since the beginning of product development in May 1997. It was almost immediately restructured due to limited funding, and it was restructured again in 2001. In the past year, the program was again restructured and merged with a joint Swedish and 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 Secretary of Defense approved the early fielding plan, which includes fielding to the Joint Lightweight 155mm cannon in fiscal year 2006, the non-line-of-sight cannon in fiscal year 2008, and the enhanced unitary round in fiscal years 2010-2011.

The net effect of these changes has been to increase 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.

Program Office Comments

The Excalibur program office provided technical comments, which we incorporated as appropriate.

F/A-22 Raptor

The Air Force's F/A-22, 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 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/A-22 System Program Office.

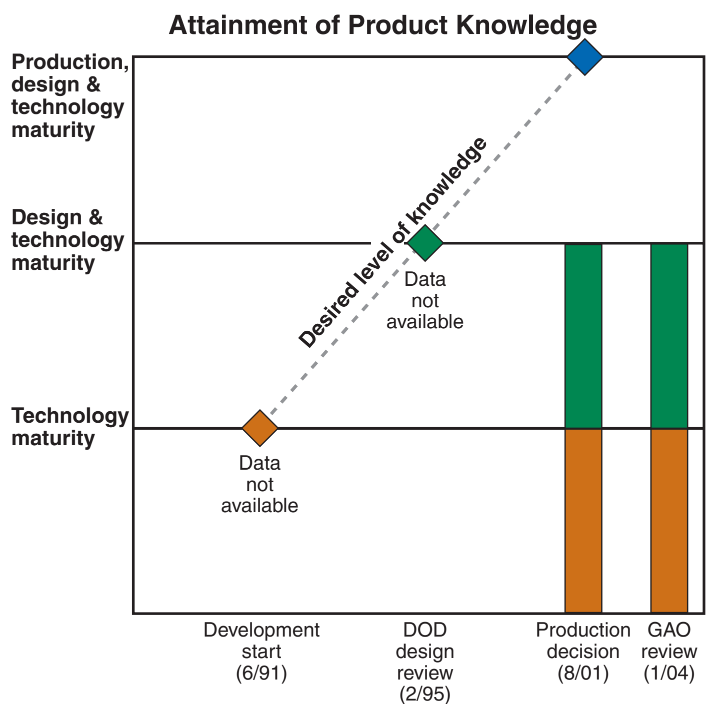
Program Essentials

Prime contractor: Lockheed Martin
Program office: Dayton, Ohio
Funding needed to complete:
- R&D: $3,642.2 million
- Procurement: $29,004.1 million
- Total funding: $33,081.2 million
- Procurement quantity: 225

Program Performance (fiscal year 2004 dollars in millions)

	As of 02/1992	Latest 01/2004	Percent change
Research and development cost	$21,266.2	$31,412.3	47.7
Procurement cost	$55,875.2	$40,313.2	-27.9
Total program cost	$77,398.2	$72,217.4	-6.7
Program unit cost	**$119.442**	**$258.844**	**116.7**
Total quantities	648	279	-56.9
Acquisition cycle time (months)	203	230	13.3

The F/A-22 Raptor entered production without assurance that production processes were in control. The Air Force expects to have about 27 percent of the aircraft on contract prior to the full-rate decision in December 2004, yet quality issues remain. For example, the F/A-22 has not achieved important reliability goals, and some components, like the canopy, are not lasting as long as expected. Technology and design matured late in the program, which contributed to numerous problems. Avionics have experienced major development problems, which caused large cost increases and testing delays. The potential for further cost increases and schedule delays exists as a significant amount of testing remains. Additionally, production costs could increase if the assumed $25 billion in offsets from cost reduction plans is not realized.



F/A-22 Raptor Program

Technology Maturity

The three critical F/A-22 technologies (supercruise, stealth, and integrated avionics) appear to be mature. However, two of these technologies, integrated avionics and stealth, did not mature until several years after the start of the development program. Integrated avionics has been a source of major problems, delaying developmental testing and the start of initial operational testing. Since 1997, the development costs of avionics have increased by over $980 million. The avionics is still considered unstable, and initial operational testing has not started. Until testing demonstrates the avionics work as intended, the program is subject to additional delays and cost increases.

Design Maturity

The F/A-22 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 have 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 is still conducting development testing and has not started operational testing. Until testing is completed, now scheduled for September 2004, the possibility of additional design changes remains.

Production Maturity

The program office stopped collecting process control information in November 2000. The contractor estimated that nearly half of the key processes had reached a marginal level of control, but not up to best practice standards. The Air Force has 52 production aircraft on contract with 22 more scheduled for contract before full-rate production approval, expected in December 2004. The contractor continues to revise its manufacturing process to gain greater efficiency and quality. However, the Air Force has not demonstrated the F/A-22 can achieve its reliability goal of 3 hours mean time between maintenance. It does not expect to achieve this goal until 2008 when most of the aircraft will have been bought. Best practices strive to achieve reliability requirements before entering production. As of mid-January 2004, the Air Force had only demonstrated about 18 percent of the reliability required at maturity.

Other Program Issues

The Air Force is counting on over $25 billion 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 plans are not achieved, production costs could increase.

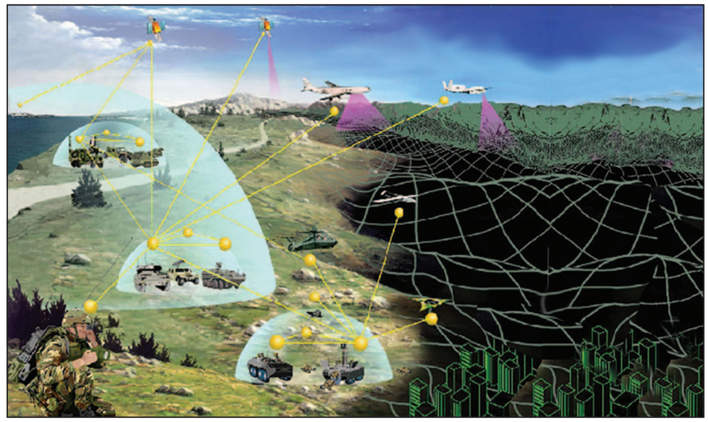
The Integrated Maintenance Information System (IMIS), a paperless computerized maintenance system, is used by the Air Force to maintain the F/A-22. The system collects and analyses problem data and develops a maintenance solution. The system has not functioned properly, causing unnecessary maintenance actions. This has affected the Air Force's ability to fly the test aircraft on schedule. The Air Force expects new software, planned to be released in February 2004, to address many of the errors generated by IMIS.

Program Office Comments

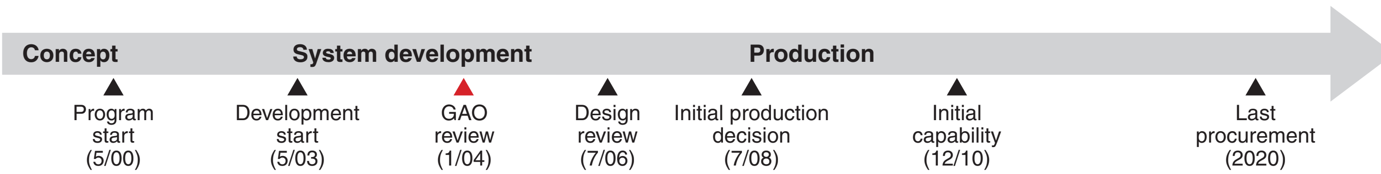
In commenting on a draft of this assessment, the program office recommended technical changes. We incorporated these comments where appropriate. The program office also pointed out that while only 18 percent of the reliability requirement had been demonstrated to date, corrections had been identified that should increase the value to 28 percent, once they are implemented. The program office also pointed out it has an interim reliability goal of 1.95 hours mean time between maintenance for the end of development.

Future Combat Systems (FCS)

The Army's FCS is 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, FCS will eventually feature 18 major systems and other enabling systems. Increment one currently includes 14 systems, and it will rely on an overarching network for information superiority and survivability. Additional systems and new technologies will be introduced as they mature and funding is available.



Source: Future Combat Systems Program Office, U.S. Army.



Program Essentials

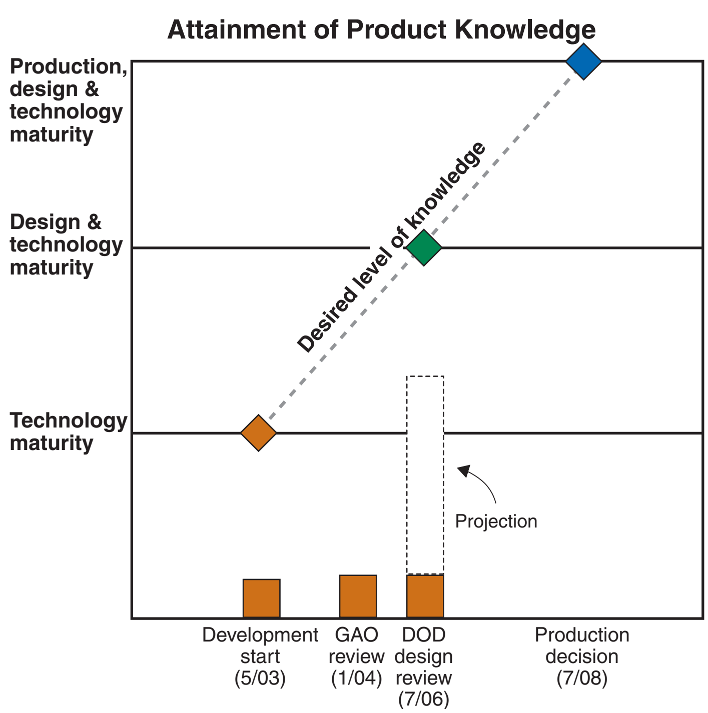
Prime contractor: Boeing
Program office: Warren, Mich.
Funding needed to complete:
R&D: $18,214.6 million
Procurement: $59,987.8 million
Total funding: $78,811.4 million
Procurement quantity: 15

Program Performance (fiscal year 2004 dollars in millions)

	As of 04/2003	Latest 10/2003	Percent change
Research and development cost	$18,371.9	$18,371.9	0.0
Procurement cost	$59,987.8	$59,987.8	0.0
Total program cost	$78,968.7	$78,968.7	0.0
Program unit cost	**$5,264.582**	**$5,264.582**	**0.0**
Total quantities	15	15	0.0
Acquisition cycle time (months)	91	91	0.0

Quantities refer to complete brigade-sized Units of Action. Each unit contains many FCS systems or platforms.

The FCS program began system development with only 4 of its 52 critical technologies mature and only 2 additional technologies are expected to reach full maturity by the time of the design review in July 2006, more than half way through product development. The program expects product maturation to continue throughout system development and full integration to be demonstrated at the time of operational testing. Maturing technologies concurrently with product development increases the risk of cost growth and schedule delays. Since FCS will dominate Army investment accounts over the next decade, cost growth and schedule delays could affect all Army acquisitions. While system development began in May 2003, the program will be reviewed in November 2004 to determine if the Army should continue the development phase and to authorize prototypes.



FCS Program

Technology Maturity

Only 4 of the FCS program's 52 critical technologies are mature and only 2 additional technologies are expected to be mature at the time of the design review in July 2006. By maturing technology while developing the FCS products, the Army has increased the risk of cost growth and schedule delays.

Design Maturity

The FCS program projects that about 80 percent of the estimated 42,750 drawings will be released to manufacturing by the time of the design review for increment one in July 2006. However, DOD may authorize developmental prototype production as early as November 2004, about 20 months prior to the design review and before these production drawings are available. These developmental prototypes, which are not intended to be production representative, will be used, along with simulations, in tests conducted before the 2008 initial production decision, to generate additional acquisition knowledge needed to help mitigate cost and schedule risks.

The FCS program represents a major integration effort, both at the weapon systems platform level and at the networked systems level. The total program involves over 33 million lines of software code and 14 weapon systems or platforms networked together. Given the size of the program, it will be a challenge to demonstrate the maturity of the entire system of systems.

Other Program Issues

The concept of an FCS equipped brigade-sized combat unit, known as a Unit of Action, represents a major departure in the way the Army has conducted combat operations and is a major part of the Army's transformation efforts. To successfully develop FCS, the Army faces a number of technological and programmatic challenges. One challenge is to equip Units of Action with a common family of networked vehicles and other systems. These vehicles and systems are expected to be a fraction of the weight of existing heavy fighting vehicles to improve transportability. For example, vehicles must be light and small enough to be airlifted by a C-130 transport, which could require lighter armor on each vehicle than existing vehicles.

Another challenge involves developing multiple systems and a network in less time than DOD typically needs to develop a single advanced system. The schedule for developing FCS is challenging and currently focuses on obtaining an initial operating capability in 2010. Even though the weapon systems have yet to be clearly defined, DOD may authorize prototype builds for testing as early as November 2004 to generate additional information needed for the 2008 production decision. Combined with the projected state of design maturity, this could result in the prototypes being significantly different than production units.

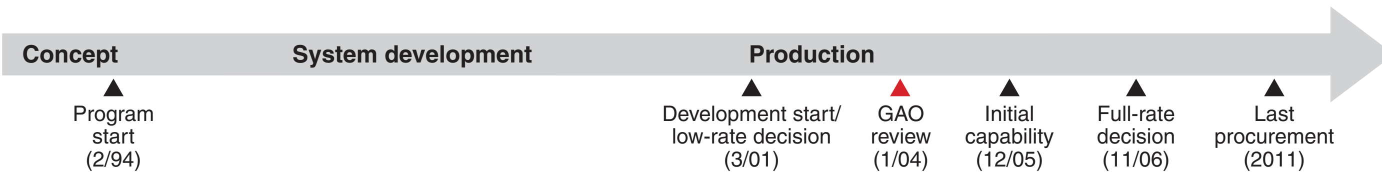
Program Office Comments

In commenting on a draft of this assessment, the program office stated that the Army guideline for technology maturity is less stringent than that recommended by GAO and that DOD is monitoring the Army's efforts to mature critical technologies to that level. The DOD approved FCS acquisition strategy indicates that critical technologies should be at the maturity level required by the Army at the time of the program's preliminary design review in April 2005 and at the maturity level recommended by us prior to the FCS production decision in 2008.

Global Hawk Unmanned Aerial Vehicle

The Air Force's Global Hawk is a high altitude, long endurance unmanned aerial vehicle with integrated sensors and ground stations providing intelligence, surveillance, and reconnaissance capabilities. Following a successful technology demonstration, Global Hawk entered system development and limited production in March 2001. Identified as a transformational system, the program was restructured in 2002 to implement an evolutionary acquisition strategy intending to more quickly develop and field a larger and more capable air vehicle.

Source: Global Hawk Program Office.



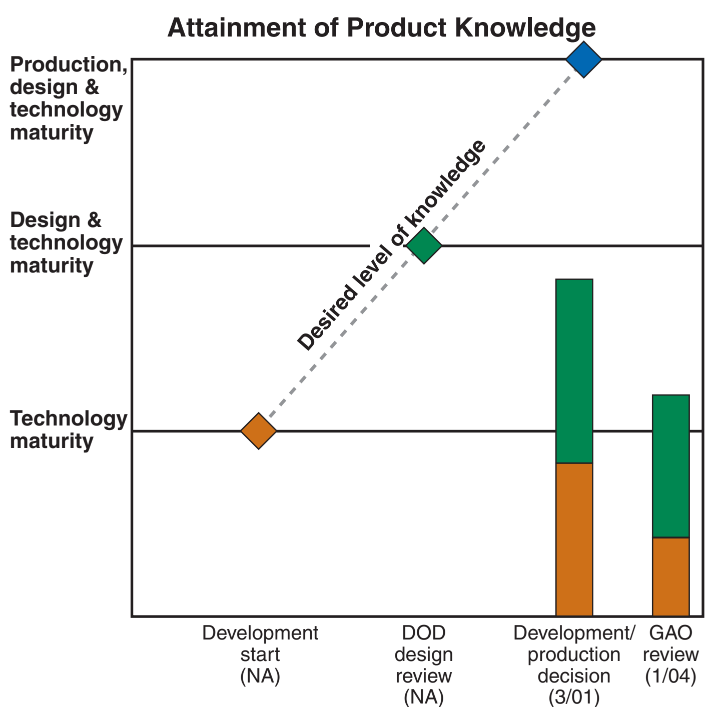
Program Essentials

Prime contractor: Northrop Grumman Integrated Systems
Program office: Dayton, Ohio
Funding needed to complete:
- R&D: $1,634.6 million
- Procurement: $2,717.5 million
- Total funding: $4,469.6 million
- Procurement quantity: 45

Program Performance (fiscal year 2004 dollars in millions)

	As of 03/2001	Latest 12/2002	Percent change
Research and development cost	$883.1	$2,320.0	162.7
Procurement cost	$3,661.6	$3,067.7	-16.2
Total program cost	$4,571.6	$5,516.8	20.7
Program unit cost	**$72.565**	**$108.173**	**49.1**
Total quantities	63	51	-19.0
Acquisition cycle time (months)	54	57	5.6

Due to program restructuring to more quickly field the larger and more capable system, key product knowledge on Global Hawk is now less than it was in March 2001. Officials originally planned to first produce systems very similar to technology demonstrators and then slowly develop and acquire more advanced systems. Technology and design maturity approached best practice standards for this plan. However, program restructuring in 2002 accelerated deliveries, overlapped development and production schedules, and added the new, larger air vehicle with enhanced sensors. These actions increased development and program unit costs. Technology and design knowledge for the restructured plan are below best practices, but they should be increased by the full-rate production decision date. Production maturity is not known; statistical process controls are being planned but are not yet in place.



Global Hawk Program

Technology Maturity

Four of 14 critical technologies associated with the Global Hawk system are mature, another 4 technologies are approaching maturity, and 6 are less mature. Overall, technology maturity is less than it was in March 2001 when the Global Hawk program was approved for product development and low-rate production. At that time, the plan was to acquire air vehicles similar to technology demonstrators in operation and whose maturity levels for its three critical technologies approached best practice standards.

The restructured program acquires 7 air vehicles similar to the demonstrators (RQ-4A) and 44 larger and more capable models (RQ-4B). The RQ-4B air vehicle has not been built or tested, and only 1 of its 11 critical technologies is considered mature. It is to have a 50 percent larger payload capacity and incorporate advanced capabilities that depend on new sensors and other enhancements in various stages of development. In particular, three critical technologies to meet user requirements—two signals intelligence sensors and an improved radar capability—are not expected to be demonstrated until after a significant number of RQ-4Bs are already produced. Officials intend to develop and integrate new technologies in a series of spiral developments, adding them to the production line as they mature. Production approval for the air vehicles with the most advanced sensors is planned for fiscal year 2007.

Design Maturity

Design maturity for the Global Hawk has not yet been achieved and varies between the two models. Engineering drawings are complete for the RQ-4A, the first seven production units. About 60 percent of the drawings for the RQ-4B have been released to manufacturing. Officials project that almost 80 percent of the drawings will be complete by the design review date in March 2004. This approaches the best practices standard of 90 percent.

The restructured program and the evolutionary acquisition approach accelerated deliveries and increased concurrency of development and production activities, resulting in greater risks to cost, schedule, and performance. Testing of the basic design of the new, larger RQ-4B will not be completed until 13 are on order and advanced procurement awarded for seven more. Problems found late in development, while production activities are taking place, may require more time, money and effort to fix. Delays or failures in developing, producing, or testing enhanced sensor capabilities, especially new signals intelligence and radar components, could severely affect cost and schedule. Production decisions for the advanced payloads will be made later as the technologies mature.

Production Maturity

Statistical process control is not yet in place at the assembly facility. As a result, Global Hawk entered low-rate production with no assurance that production processes were in control. Program officials said that the contractor is in the process of planning and collecting data to implement control techniques for key manufacturing tasks. Manufacturing performance is currently monitored by such quality control measures as manufacturing defects per opportunity and rework data. The quality data for the second production vehicle shows improvement over the first vehicle. Contract performance data indicates that work is slightly behind schedule and over cost.

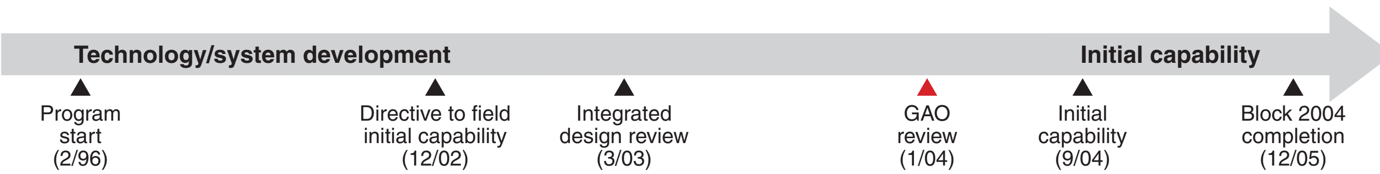
Program Office Comments

In commenting on a draft of this assessment, the program office generally concurred and provided the following statements on acquisition strategy and risk management. A successful technology demonstration supported a coordinated development and initial production start. The evolutionary acquisition strategy was implemented to deliver an early combat capability followed by time-phased incremental improvements. Program risk is managed through incremental production decisions, tailored testing, interim management reviews, and contract awards of each new capability. The program benefited by operational experiences gained in the technology demonstration and in extensive combat missions in the war on terror. These experiences helped refine operational needs and allowed user-requested improvements to be incorporated into first deliveries with minimal program impact. The Global Hawk system transforms military operations providing persistent, near real-time intelligence to combat commanders.

Ground-Based Midcourse Defense (GMD)

MDA's GMD element is being developed in incremental, capability-based blocks to defend the United States against limited long-range ballistic missile attacks. The first block consists of a collection of radars and an interceptor—a three-stage booster and an exoatmospheric kill vehicle (EKV)—integrated by a central control system that formulates battle plans and directs the operation of GMD components. We assessed the initial capability to be fielded in September 2004, and Block 2004 to be completed by December 2005.

Source: Ground-Based Midcourse Defense.



Program Essentials

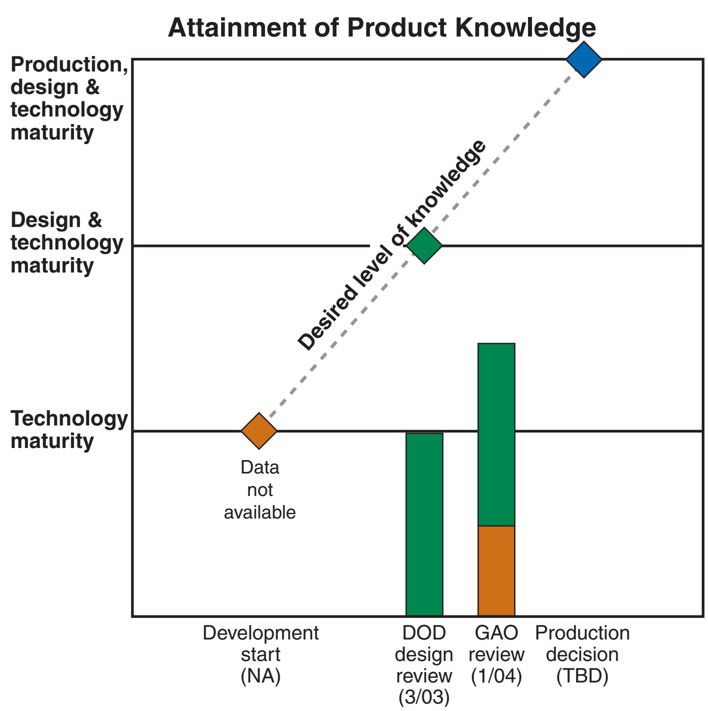
Prime contractor: Boeing Company
Program office: Huntsville, Ala.
Funding to complete through 2009:
- R&D: $9,532.8 million
- Procurement: $0.0 million
- Total funding: $9,532.8 million
- Procurement quantity: TBD

Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 02/2003	Percent change
Research and development cost	NA	$22,517.3	0.0
Procurement cost	NA	$0.0	0.0
Total program cost	NA	$22,517.3	0.0
Program unit cost	**NA**	**$22,517.3**	**0.0**
Total quantities	NA	1	0.0
Acquisition cycle time (months)	NA	TBD	TBD

Latest cost includes all costs from the program's inception through fiscal year 2009. Procurement funding and quantities have yet to be determined. NA = not applicable

Three of GMD's 10 critical technologies are mature, and the design appears stable. Three technologies are expected to be fully mature by the third quarter of fiscal year 2004. Of the remaining four technologies, three are expected to reach maturity by December 2005, but it is not known when the final technology will reach maturity. The program has released about 89 percent of system engineering drawings, but until all technologies are demonstrated, the potential for design change remains. By beginning integration before these technologies have been demonstrated, MDA has accepted higher risks associated with potential cost growth, schedule slippage, or decreased performance. Finally, questions over whether the contractors can produce the interceptor at planned rates and problems with one of the boosters raise concerns about the program's ability to field the expected capability by December 2005.



GMD Program

Technology Maturity

Only 3 of GMD's 10 critical technologies are mature—one of the boosters; the EKV's infrared seeker; and the fire control software of the battle management component. MDA expects to demonstrate the maturity of 3 other technologies—two EKV technologies and the battle management component—by the third quarter of fiscal year 2004. Three critical technologies—a second booster, the sea-based X-Band Radar, and the early warning radar at Beale Air Force Base, California—are expected to be fully mature by December 2005. It is not clear if the final technology—the upgraded Cobra Dane radar—will reach maturity by September 2004.

Although MDA is developing two boosters, only one booster—known as OSC—will have reached maturity prior to the initial capability in September 2004. While the OSC booster was tested successfully in August 2003, the other booster—known as BV+—has experienced continual delays in flight and booster tests, indicating development problems. GMD's three radar components, needed to detect and track enemy missiles, are the least mature. Software for the Beale radar is still under development. Although the planned sea-based X-Band Radar uses existing technology, it has not been demonstrated in its new environment, a platform located in the ocean. Finally, it is unclear if the Cobra Dane Upgrade—GMD's primary radar when first fielded—will reach full maturity prior to September 2004 because MDA does not plan to demonstrate its capability in integrated flight tests. The anticipated launch of foreign test missiles might serve as a test of the radar, but testing in this manner might not provide all of the needed information, since MDA will not control the configuration of the target or the flight environment.

Design Maturity

The GMD program has released about 89 percent of all engineering drawings needed to produce an initial capability, indicating design stability. The ongoing effort to mature critical technologies, however, may lead to more design changes.

Production Maturity

We did not assess the production maturity of GMD because process control data was unavailable. The program plans to deliver five interceptors to meet the initial capability target in September 2004, with 15 additional interceptors to be delivered by December 2005, splitting booster production between two manufacturers. It remains unclear whether GMD can meet this schedule and program officials admit that the interceptor production schedule is high risk. The contractors have not yet proven that they can manufacture the EKV at the planned rate or that they can accelerate production of the OSC booster quickly enough to manufacture all five boosters needed for the initial capability. Finally, due to an explosion at a subcontractor facility and questions related to its development, the BV+ booster is at risk of not meeting its production goals for the December 2005 capability.

Other Program Issues

Approximately $3.4 billion in funding that MDA expects to use to accomplish activities in fiscal years 2004 and 2005 contribute directly to the development of Block 2004, but were budgeted as future block activities. While funding has not been moved between blocks, the actual estimated cost of Block 2004 will be higher than the amount reflected in budget estimates. In addition, using contractor cost performance data, we independently estimate that the contract will overrun its budget by between $237 million and $467 million at its completion in 2007, with the interceptors accounting for approximately 84 percent of this overrun.

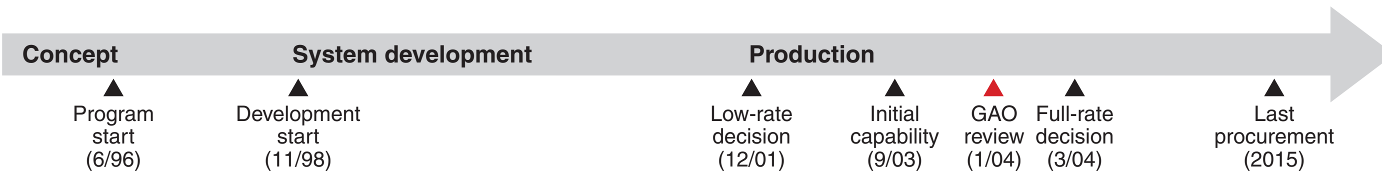
Program Office Comments

In commenting on a draft of this assessment, the program office acknowledged that a portion of the funding budgeted for Block 2006—the next increment—directly supports Block 2004 efforts. Program officials expressed concern that our assessment could give the incorrect impression that Block 2004 has incurred a $3.4 billion cost overrun or that funding is intentionally being moved to complete Block 2004. The program office also noted that the prime contractor is reporting no cost overrun at the completion of the contract. Although the contractor estimates that the interceptor will have an overrun of approximately $135 million at its completion, it will be offset by underruns in other program areas.

Joint Air-to-Surface Standoff Missile (JASSM)

JASSM is a joint Air Force and Navy missile system designed to attack surface targets outside of the range of area defenses. JASSM will be delivered by a variety of aircraft including the F-16 C/D, the B-52H, the F/A-18E/F, the B-2, and the B-1B. The system includes the missile, software, and software interfaces with the host aircraft and mission planning system. We assessed all components.

Source: Joint Air-to-Surface Standoff Missile (JASSM) Program Office (Development Test Mission - DT-5).



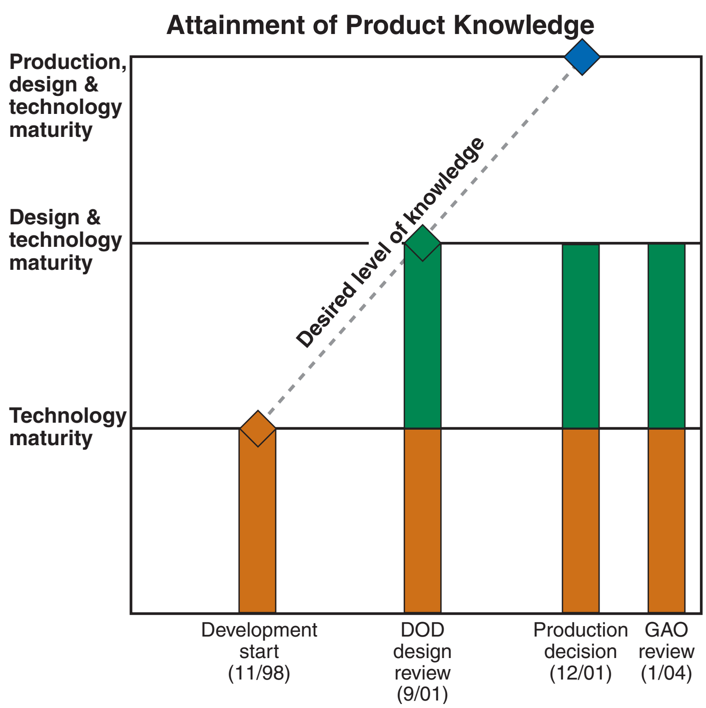
Program Essentials

Prime contractor: Lockheed Martin
Program office: Fort Walton Beach, Fla.
Funding needed to complete:
R&D: $262.7 million
Procurement: $2,458.3 million
Total funding: $2,721.0 million
Procurement quantity: 4,164

Program Performance (fiscal year 2004 dollars in millions)

	As of 11/1998	Latest 07/2003	Percent change
Research and development cost	$866.0	$1,215.0	40.3
Procurement cost	$1,078.2	$2,550.4	136.6
Total program cost	$1,964.8	$3,765.4	91.6
Program unit cost	**$0.796**	**$0.849**	**6.7**
Total quantities	2,469	4,434	79.6
Acquisition cycle time (months)	75	86	14.7

The JASSM program entered production in December 2001 without ensuring that production processes were in control. However, program officials indicated that they have demonstrated the production processes by sampling statistical data at the subsystem level. The program used mature technology, and the design was stable at the design review. Although there were some developmental and operational test failures, program officials incorporated fixes that subsequent tests demonstrated to be successful. The contractor has been able to produce at the rates required for the initial production.



JASSM Program

Technology Maturity

The JASSM program used existing technologies and the level of technology maturity is high. Although none of the subsystems are based on new technologies, three critical technologies are new applications of existing technologies. These three technologies are the global positioning system anti-spoofing receiver module, the low observable technology, and the composite materials. These technologies are mature.

Design Maturity

The contractor has released 100 percent of the drawings to manufacturing and has completed developmental and operational tests. The full-rate production decision is scheduled for March 2004, pending an analysis of these tests. Developmental tests were completed in March 2003. Fourteen developmental flight tests were performed, with 3 tests failing to meet the test objectives. Program officials stated that they identified the issues involved and incorporated fixes. The fixes were successfully tested in later developmental tests. Eleven operational tests were also performed from June 2002 to September 2003. The Air Force Operational Test and Evaluation Command evaluated the results of these tests and rated the JASSM as effective and potentially suitable and recommended for full-rate production.

Production Maturity

Program officials do not collect production process control data at the system level. However, they stated that all production processes had been demonstrated and that statistical data is collected at the subsystem level and is sampled as required. Program officials indicated that the contractor has produced at the rates required for the low-rate initial production buy of 176 missiles and that it will be able to produce at the full-rate production level of 250 missiles per year. Program officials believe that none of the manufacturing processes that affect critical system characteristics are a problem, although there are key production processes that have cost implications, such as bonding for the low observable materials and the painting/coating application.

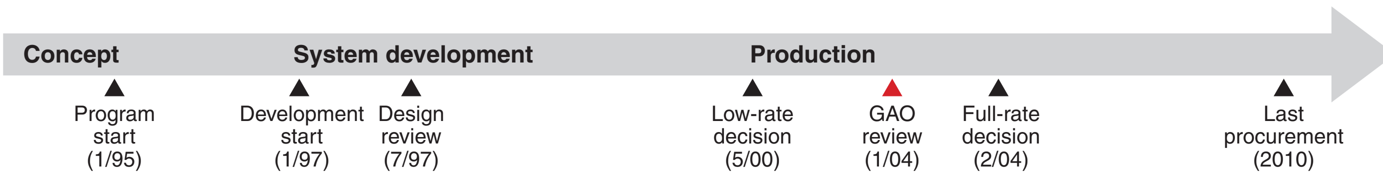
Program Office Comments

In commenting on a draft of this assessment, the program office stated that the JASSM program development phase concluded during 2003. All developmental test vehicles were delivered and successfully tested during this period. This year also included the required deliveries from the first low-rate initial production of 76 missiles, with the second low-rate initial production contract of 100 missiles ongoing, and the third contract for 200 missiles awarded in December 2003. Additionally, the contractor built 3 more operational test missiles than planned during this time period. Lastly, the program office expects to award a contract for an extended range JASSM in early 2004.

Joint Helmet Mounted Cueing System (JHMCS)

JHMCS is a joint Air Force and Navy program, led by the Air Force. The system is designed to cue radars and weapons at a target based on where the pilot is looking. This avoids having to line up the aircraft with the intended target. The system works with the Navy and Air Force AIM-9X missile on the F-18, F-15, and F-16 aircraft. JHMCS also provides situational awareness by displaying information about the aircraft and weapons. Development is jointly funded by the services, and procurement is funded by the aircraft platforms.

Source: JHMCS System Program Office.



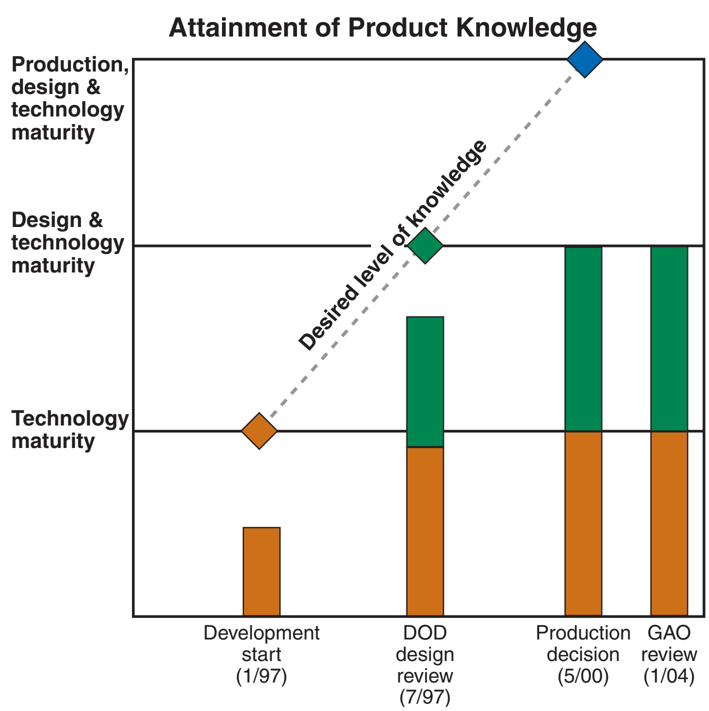
Program Essentials

Prime contractor: Boeing
Program office: Dayton, Ohio
Funding needed to complete:
- R&D: $0.0 million
- Procurement: $161.2 million
- Total funding: $161.2 million
- Procurement quantity: 924

Program Performance (fiscal year 2004 dollars in millions)

	As of 11/1996	Latest 09/2003	Percent change
Research and development cost	$217.2	$229.8	5.8
Procurement cost	$425.5	$883.0	107.5
Total program cost	$642.7	$1,112.8	73.1
Program unit cost	**$0.327**	**$0.533**	**63.0**
Total quantities	1,965	2,087	6.2
Acquisition cycle time (months)	TBD	TBD	TBD

Although JHMCS has been in production for 3 years, data has not been collected on whether its production processes are in control. The program has experienced design defects and quality control problems. Operational testing, completed in August 2002, found that while the system was operationally effective, it was not suitable to be fielded due to low reliability and maintainability. JHMCS is in its fourth low-rate initial production effort, and a decision for full-rate production is anticipated in February 2004. We did not assess the maturity of critical technologies at development start.



JHMCS Program

Technology Maturity

All six of the JHMCS program's critical technologies are mature and have been demonstrated in an operational environment using production representative hardware. We did not assess critical technology maturity at development start because the program is well into production.

Design Maturity

The JHMCS design appears complete. Operational testing, completed in June 2002, found that while the system was operationally effective, it was not suitable to be fielded due to low reliability and maintainability caused by design defects and poor quality control. The recently released Beyond Low Rate Initial Production Report indicates some improvement in these areas. However, JHMCS is still not compatible with pilot night vision systems or laser eye protection, a finding that partly led to the conclusion that the system was operationally not suitable. Resolving these issues could result in design changes.

Production Maturity

Production maturity could not be determined because the contractor does not use statistical process controls to ensure that production processes are stable. To date, approximately 218 systems have been delivered to the Air Force and 124 systems to the Navy. The program is in its fourth low-rate initial production buy and the full-rate production decision is likely to be made early next year.

Other Program Issues

The Air Force and the Navy purchased 35 percent of the total quantities of the system under low-rate initial production, despite reliability and maintainability issues identified in testing.

The full capability of the JHMCS program will not be available until it is deployed with the AIM-9X missile. However, almost 85 percent of the total JHMCS quantities for the F-16 will be under contract before the AIM-9X missile is fielded on the aircraft. In addition, the Air Force deferred indefinitely incorporation of JHMCS onto the F-22. Current plans call for a separate development effort for a helmet mounted cueing system for the aircraft.

Program Office Comments

In commenting on a draft of this assessment, the program office stated that the JHMCS capability is not dependent on AIM-9X deployment, nor is the JHMCS utility limited to the air-to-air arena. Users are finding the increased situational awareness, while using JHMCS air-to-ground, is outstanding. JHMCS is being installed in aircraft at logical, cost-effective times, principally in planned aircraft modification and production lines, and is not necessarily linked to other weapons or avionics upgrades.

JHMCS has basic production maturity. Companies producing the bulk of system hardware are ISO-9000 certified. Statistical process controls are used, but data is not reported to the program office.

JHMCS reliability has more than doubled in the last year via system improvements and increased user proficiency.

A separate program is underway to integrate night vision devices with JHMCS. An interim solution to laser eye protection has been identified. Further improvements will require a new laser eye protection program.

Joint Common Missile

The Joint Common Missile is an air-launched and potentially ground-launched missile designed to target tanks; light armored vehicles; missile launchers; command, control, and communications vehicles; bunkers; and buildings. It will be a joint Army and Navy program with Marine Corps participation and United Kingdom involvement. It will provide line-of-sight and beyond line-of-sight capabilities. It can be employed in a fire-and-forget mode—providing maximum survivability—or a precision attack mode, providing the greatest accuracy.

Source: Joint Common Missile Project Office.

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

- Program start (10/01)
- GAO review (1/04)
- Program/development start (4/04)
- Low-rate decision (4/08)
- Full-rate decision (12/09)

Program Essentials

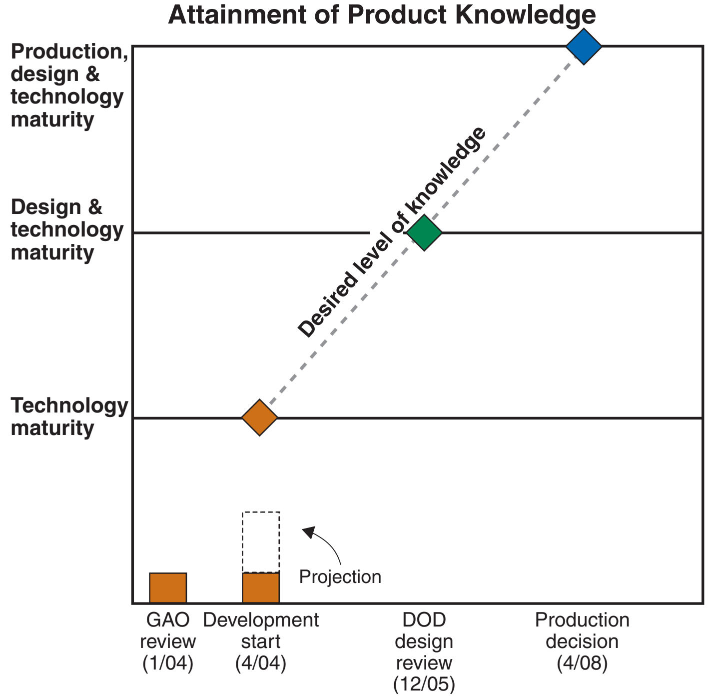
Prime contractor: Raytheon/Boeing/Lockheed Martin
Program office: Huntsville, Ala.
Funding needed to complete:
R&D: TBD
Procurement: TBD
Total funding: TBD
Procurement quantity: TBD

Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 09/2003	Percent change
Research and development cost	NA	$777.96	0.0
Procurement cost	NA	$2,118.10	0.0
Total program cost	NA	$2,896.06	0.0
Program unit cost	NA	**$0.255**	**0.0**
Total quantities	NA	11,361	0.0
Acquisition cycle time (months)	NA	65	NA

The Joint Common Missile is scheduled to enter system development of the air-launched version before any of its critical technologies are fully mature. Program officials currently project that the critical technologies will reach maturity 3 months after design review, about half way through product development.

Attainment of Product Knowledge



Joint Common Missile Program

Technology Maturity

None of the Joint Common Missile's three critical technologies have demonstrated full maturity according to best practices. These technologies include a multi-mode seeker for increased countermeasure resistance, boost-sustain propulsion for increased standoff range, and a multi-purpose warhead for increased lethality capability. Program officials noted that many of the components of these technologies are in production on other missile systems, but they have not been fully integrated into a single missile. While backup technologies exist for each of the critical technologies, substituting any of them would result in degraded performance or increased costs.

Design Maturity

Program officials project that full integration of the subsystems into the Joint Common Missile will occur by June 2005 and that the system will reach maturity by December 2005, over 1-1/2 years after the start of system development and demonstration.

Program officials believe that the program's modular design will reduce life-cycle costs, including demilitarization, and will enable continuous technology insertion to ensure improvements against advancing threats.

Other Program Issues

Current cost estimates are likely to increase because the program has yet to incorporate the full Army and Navy quantities. The Army's previous estimate of 54,290 was based on the AH-64D Apache and the Comanche. The current estimate does not include the Comanche. The Navy's previous estimate of 23,000 increased because of additional requirements.

Program Office Comments

In commenting on a draft of this assessment, the program office stated that during the fourth quarter of 2003 the Army recommended, and DOD approved, the restructure of the Joint Common Missile system development and demonstration program from a 36-month spiral development to a 48-month two-phase program to reduce risk. A risk reduction phase of 12 to 14 months will allow full integration of the subsystems in a missile prior to the initiation of system demonstration. Program officials stated that they demonstrated the technology maturity required by DOD acquisition system policy via tower tests, captive flight tests and the development and submittal to the government for verification of an integrated flight simulation using the tactical seeker software. Joint Common Missile development will be demonstrated in an operational environment in December 2005. A system integration and demonstration phase of 36 months will lead to a low-rate initial production decision in April 2008. Beginning in fiscal year 2009 and running through fiscal year 2012, additional capabilities, such as man-in-the-loop target update and antiradiation homing variant, will be added. This portion of the program does not currently have a DOD approved acquisition strategy.

Joint Strike Fighter (JSF)

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

Source: JSF Program Office.

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

- Program start (11/96)
- Development start (10/01)
- GAO review (1/04)
- Low-rate decision (4/06)
- Initial capability USMC (4/10)
- Initial capability USAF (6/11)
- Initial capability USN (4/12)
- Last procurement (2026)

Program Essentials

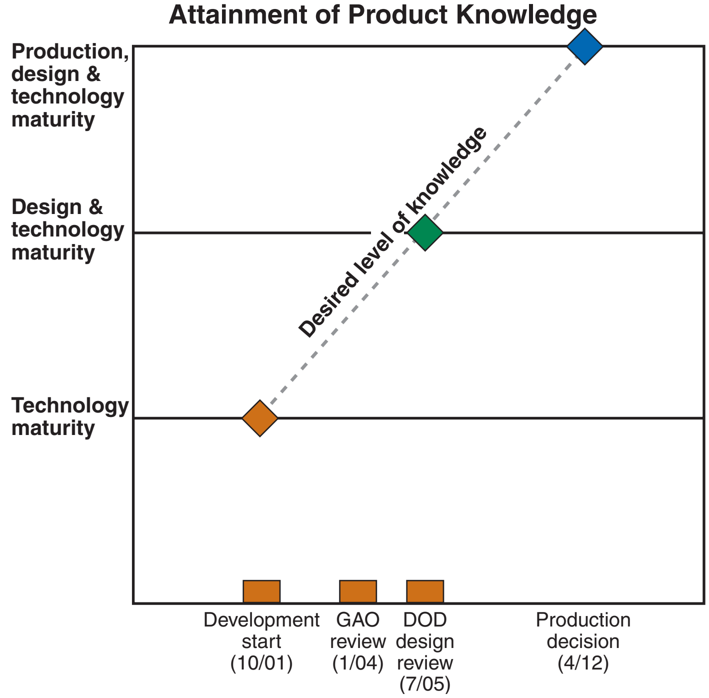
Prime contractor: Lockheed Martin Aeronautics
Program office: Arlington, Va.
Funding needed to complete:
R&D: $26,080.6 million
Procurement: $128,860.8 million
Total funding: $155,173.9 million
Procurement quantity: 2,443

Program Performance (fiscal year 2004 dollars in millions)

	As of 10/2001	Latest 12/2002	Percent change
Research and development cost	$33,046.9	$36,185.9	9.5
Procurement cost	$146,613.5	$128,860.8	-12.1
Total program cost	$181,195.0	$165,279.2	-8.8
Program unit cost	**$63.222**	**$67.269**	**6.4**
Total quantities	2,866	2,457	-14.3
Acquisition cycle time (months)	185	185	0.0

The JSF program entered system development without demonstrating the maturity of its eight critical technologies. The JSF program no longer focuses on those technology areas; instead it uses a different method of integration and risk management that tracks 28 program level risks. We were unable to assess the new risk areas, but program data indicates that 5 are high, 20 are moderate, and 3 are low risk. We obtained no data that indicates that the technological maturity has changed. Contractor efforts since the start of product development have focused on the design and producibility of technology, not on further demonstrating technology maturity. By its design review in 2005, the program expects to have 100 percent of its critical drawings (referred to as build-to-packages) completed for the Air Force and Marine Corps versions and 80 percent completed for the Navy version.

Attainment of Product Knowledge



JSF Program

Technology Maturity

During its concept development phase, JSF had eight critical technologies: short take-off vertical landing/integrated flight propulsion control, prognostic and health management, integrated support systems, subsystems technology, integrated core processor, radar, mission systems integration, and manufacturing. We reported in May 2000, and again in October 2001, that low levels of maturity in these technologies could increase the likelihood of cost and schedule growth.

An independent review performed by DOD in 2001, using a different method than technology readiness levels, concluded that the overall technology maturity of the JSF program was sufficient to enter into system development. Contractor efforts since that time have focused on the design and producibility of the technology elements, not on furthering the technology beyond that already demonstrated at the start of the current phase. We obtained no data that indicates that the technological maturity has changed. The program now uses Lockheed Martin's Key System Development Integration approach to monitor overall technology and design integration. Further, the program currently tracks 28 program level risk areas and has assessed 5 as high, 20 as moderate, and 3 as low risk. This represents an increase in risk from last year when only 23 overall program risks were identified with 2 high, 18 moderate, and 3 low risk areas. We did not evaluate the current JSF technique for assessing risks.

Design Maturity

The program office has not provided information on the number of drawings completed for any of the JSF versions. The preliminary design review in March 2003 revealed significant issues related to airframe design immaturity and other areas. At that time, estimates were about 5,000 pounds above targets.

While much of this overage has been reduced through better estimating, design changes, and improved structural efficiency, the program will still require reductions in aircraft specifications to meet requirements for the Air Force version. Further estimating and weight reduction assessments are being performed to determine the impact on the Navy and Marine Corps versions. In addition, Lockheed Martin's detailed design efforts for the Air Force version have been delayed by 2 months due to immature design tools, required structural analysis, design team training, and redesigns because of overweight items. Consequently, the program has a current $103 million unfavorable schedule variance and the first flight for all three versions could be delayed by 3 months.

Other Program Issues

The Director, Operational Test and Evaluation, expects numerous test challenges for the program, including the integration of highly advanced sensors with the avionics systems, vertical thrust capability for the Marine Corps version, and performance and maintenance requirements of the low observable capabilities. According to program documentation, vulnerability assessments for live fire test and evaluation indicate that the current design will not meet requirements.

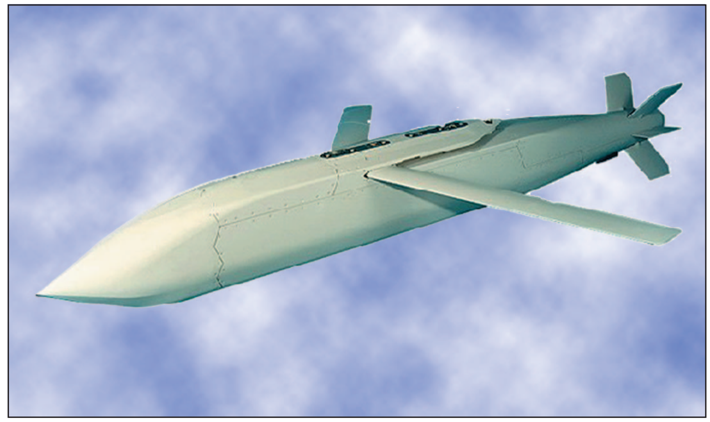
In July 2003, we recommended increased program oversight to adequately plan for incorporation of foreign suppliers to protect sensitive U.S. technology and meet program goals.

Program Office Comments

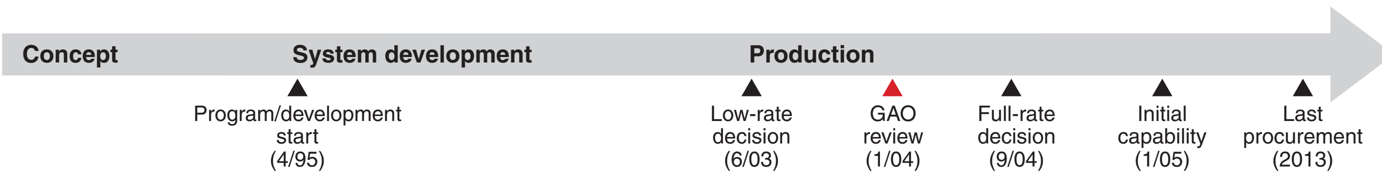
In commenting on a draft of this assessment, the program office stated that DOD conducted an independent review in 2001 and concluded that the technology maturity was sufficient to proceed into system development. For this phase, JSF has adopted Lockheed Martin's approach of Program Risk mitigation and Key System Development Integration (KSDI) plans to monitor overall technology development and design integration as a best practice. The program continues to address the 8 critical technology categories through the this process. All 8 categories are mapped to the KSDI, while 4 of the 8 are also mapped to Program Risk plans. Furthering technology maturity is inherent in the development and risk management process. Teams have traveled throughout the world looking for better technologies to fit requirements. Also, existing Small Business and Innovative Research and Science and Technology efforts across the Navy, Air Force, and partner countries are focused on this area. JSF is addressing technical issues primarily focused on weight. Maturity of the original eight technology categories is not related to current weight issues.

Joint Standoff Weapon (JSOW)

JSOW is a joint Air Force and Navy guided bomb to attack targets from outside the range of most enemy air defenses. A dispenser variant (JSOW A) carries submunitions to attack soft targets. In 2002, the Joint Requirements Oversight Council deferred production of an antiarmor JSOW variant (JSOW B). The unitary variant (JSOW C) uses a seeker, autonomous targeting acquisition software, and a single warhead to attack targets. All the variants use a common air vehicle. We assessed the unitary variant and the common air vehicle.



Source: Raytheon.



Program Essentials

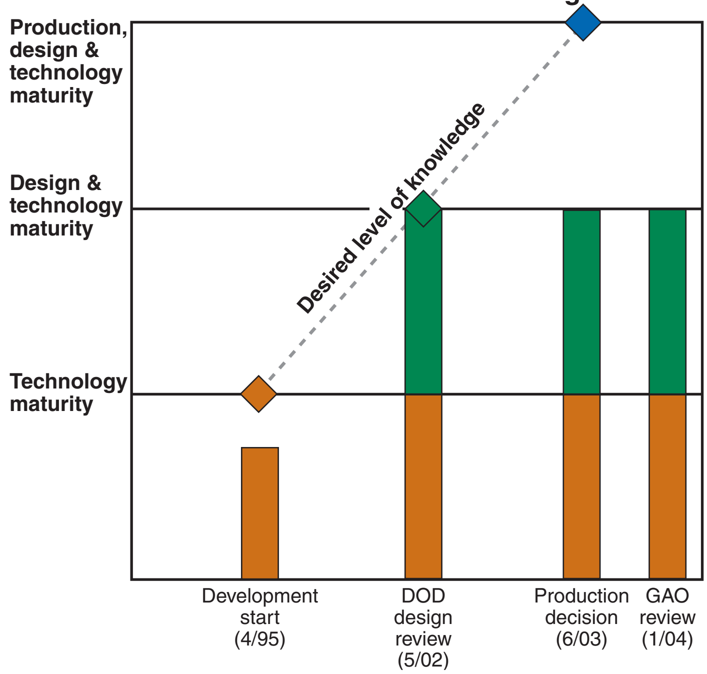
Prime contractor: Raytheon Missile Systems
Program office: Patuxent River, Md.
Funding needed to complete:
- R&D: $0.0 million
- Procurement: $784.6 million
- Total funding: $784.6 million
- Procurement quantity: 2,915

Program Performance (fiscal year 2004 dollars in millions)

	As of 04/1995	Latest 09/2003	Percent change
Research and development cost	$330.3	$321.3	-2.7
Procurement cost	$3,985.7	$840.5	-78.9
Total program cost	$4,316.0	$1,161.8	-73.1
Program unit cost	**$0.553**	**$0.387**	**-30.0**
Total quantities	7,800	3,000	-61.5
Acquisition cycle time (months)	89	117	31.5

The JSOW program began low-rate production in June 2003 without knowing whether production processes were in control. However, the contractor has begun studies to determine the feasibility of using statistical process controls for production. The program relies on an after-production process of inspection to discover defects. An operational assessment is complete, but operational evaluation will not start before award of the low-rate production contract.

Attainment of Product Knowledge



JSOW Program

Technology Maturity

The JSOW unitary variant's technology appears mature. The program office identified the imaging infrared seeker with the autonomous acquisition software as the only critical technology for the system. The seeker was not mature at the start of development, but it did demonstrate maturity in October 2001—about three-fourths through development—when it was flown aboard an aircraft in a captive flight test. Program officials stated that in seven developmental tests, three free-flight tests with the seeker only and four combined seeker/warhead tests, the seeker's performance substantially exceeded requirements.

Design Maturity

The JSOW unitary variant's basic design appears complete. At the system design review in May 2002, the program office had completed 99 percent of the drawings. The Navy completed 10 developmental tests (adding one combined seeker/warhead test in 2003) in its development program— three sled tests with the warhead, three free-flights with the seeker, and four combined warhead/seeker tests. However, the Navy delayed the beginning of operational evaluation to resolve a problem with the fuze. In the third warhead test, the charge penetrated the target, but the follow-through charge failed to detonate. The program office identified the cause, incorporated a change, and confirmed the change through additional testing.

Production Maturity

JSOW production maturity could not be determined because the contractor does not use statistical process controls. Rather, the contractor uses a process of post-production inspection to control production quality. Raytheon is investigating a defect reduction program and is evaluating the use of statistical process controls where feasible. According to program officials, 20 percent of their suppliers already use statistical process controls. Program officials report that the contractor has met the production schedule for more than 2 years for the JSOW baseline variant and that the scrap and rework rates remain low.

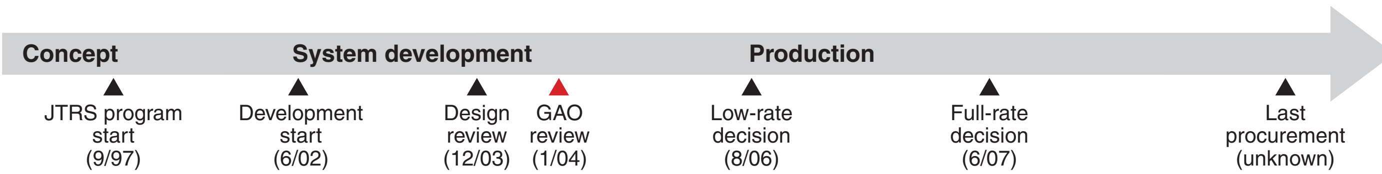
Program Office Comments

In commenting on a draft of this report, the program office said that Raytheon Missile Systems, the JSOW prime contractor, is responsible for final assembly of the missile and that the assembly process does not lend itself to a heavy statistical process control program. However, components of the process, such as the circuit card assembly, have a robust statistical process control program, and many of Raytheon's key subcontractors have active statistical process control programs where processes are closely monitored and controlled. Further, Raytheon's Supplier Management Teams that manage first- and second-tier suppliers, meet monthly, at a minimum, or more often if necessary, to address issues.

Joint Tactical Radio System (JTRS)

The JTRS program is developing software-defined radios that will interoperate with existing radios and significantly increase communications capabilities. A joint service program office is responsible for developing the JTRS architecture and waveforms, while service-led program offices will develop and procure radio hardware for platforms with similar requirements. We assessed Cluster 1, led by the Army, which is developing radios for ground vehicles and helicopters.

Source: PM WIN-T JTRS Cluster 1.



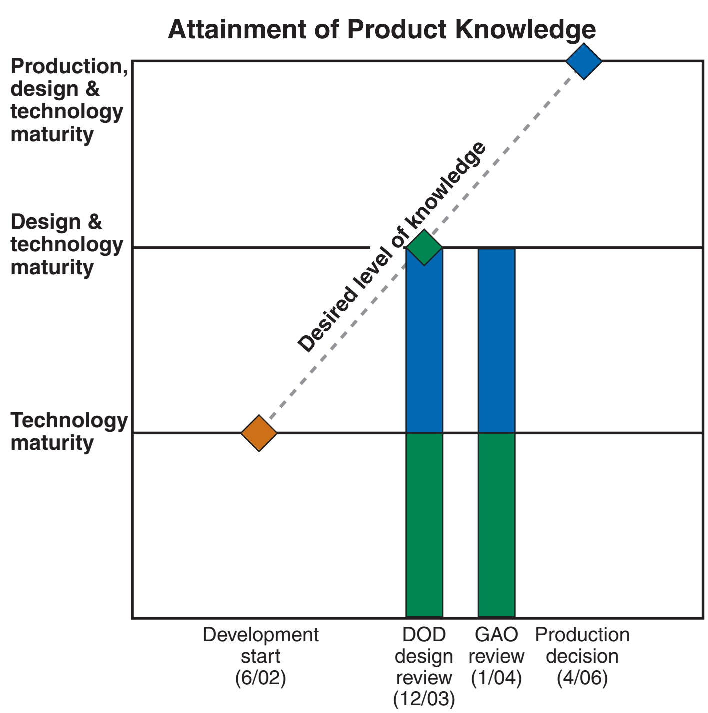
Program Essentials

Prime contractor: Boeing
Program office: Fort Monmouth, N.J.
Funding needed to complete:
- R&D: $641.8 million
- Procurement: $7,453.4 million
- Total funding: $8,095.3 million
- Procurement quantity: 108,097

Program Performance (fiscal year 2004 dollars in millions)

	As of 06/2002	Latest 11/2003	Percent change
Research and development cost	$864.6	$844.5	-2.3
Procurement cost	$13,906.4	$13,843.1	-0.5
Total program cost	$14,771.0	$14,687.5	-0.6
Program unit cost	**$0.136**	**$0.135**	**-0.6**
Total quantities	108,388	108,414	0.0
Acquisition cycle time (months)	55	58	5.5

The JTRS Cluster 1 program's demonstrated knowledge is difficult to characterize. Almost all engineering drawings have been completed, and key production processes are in control, suggesting design stability and production maturity. However, until the technologies are demonstrated, the potential for change remains. Officials do not expect to achieve technology maturity until late 2004, when prototype radios will be tested. In December 2003, the program attained design stability for the Cluster 1 radio, though the program projects the need for additional design drawings for various installation packages to install on different platforms. The program claims to have production processes in statistical control at this point; however, as development transitions to low-rate production, the program expects this may change as a result of design enhancements and technology insertion.



JTRS Program

Technology Maturity

None of the JTRS Cluster 1 program's 20 critical hardware and software technologies are mature according to best practice standards. Many of these critical technologies have been used in other radio applications, but cannot be assessed as mature because they have not been integrated into a Cluster 1 radio set. Mature backup technologies exist for some critical technologies, but program officials have cautioned that substituting them could complicate integration or result in degraded performance. The program recently experienced a 4-month schedule slip that officials attribute to short-term technology deviations affecting size, weight, and power requirements of Cluster 1 radio sets. Program officials do not expect these issues to be resolved until the system is in full-rate production.

Design Maturity

The program reports achieving design stability for the basic Cluster 1 radio design. The program recently completed its design review after a delay of 5 months. The program's design consists of two major components—the B kit, which is the basic Cluster 1 radio, and the A kit, which is the installation components to integrate the radio with the host platforms. The B-kit design is complete. The A-kit design drawings are expected to increase as the platforms to be equipped with Cluster 1 radios are better defined. The program does not attribute this expected increase to the design of the Cluster 1 radio itself, which it considers stable, but rather to the uncertainty about the design of the A-kit, which involves mounting fixtures, cables, antennas, and other such components required for integration of the radio with host platforms. As more platforms are identified for Cluster 1 sets, more A-kit design drawings will be required. The undefined design centers largely on the Army's FCS components.

Production Maturity

The program reports that most production processes to be utilized in manufacturing the JTRS radios are mature and in statistical control. The program office, however, expects the number of processes to change due to anticipated design enhancements and/or technology insertion.

Other Program Issues

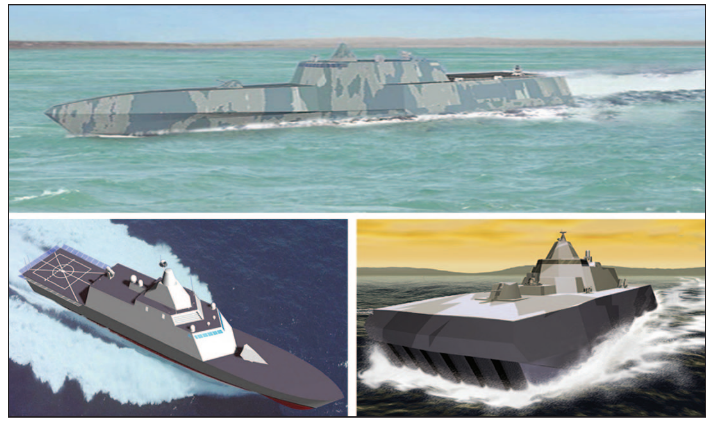
The JTRS Cluster 1 program has made considerable progress, but it faces several challenges that could affect a successful outcome. The program entered product development with an ambitious schedule that program officials recognized as high risk. In particular, the program has a software development plan with insufficient schedule reserve to incorporate knowledge gained from initial development increments and a compressed test and evaluation phase that leaves little room for rework. The JTRS Cluster 1 information security certification approach is also unprecedented, and the radios must go through a certification process that is outside the program office's control. Further technical challenges that could affect the program include platform integration, networking, and spectrum certification.

Program Office Comments

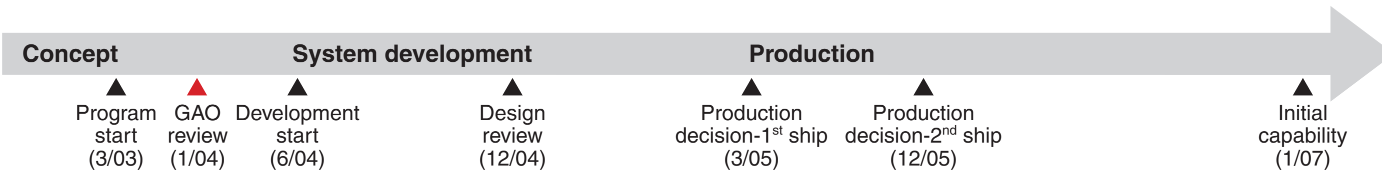
The program office generally concurred with our assessment and noted that the number of slots in the Cluster 1 radio design decreased from six to five mainly as a result of heat dissipation issues encountered during the critical design review completed in December 2003. In response to further questions, officials stated that they do not expect the change to reduce the number of channels the radio will run, but acknowledged that some of the channels will need to be mounted in external vehicle mounts rather than in the radio itself. Officials added that they do not anticipate this change having any additional impact on performance.

Littoral Combat Ship (LCS)

The Navy's LCS will be a fast, maneuverable, shallow draft ship for littoral warfare. It will use innovative hull designs to create a self-deploying and self-sustaining ship. LCS will utilize interchangeable mission modules to address three mission areas: mine, antisubmarine, and small boat surface warfare. This review focuses on the technology maturity of the mission modules for the two ships that comprise the initial acquisition. Because competition for the hull is continuing, we did not assess maturity of the sea frame itself.



Source: General Dynamics, Raytheon Company, and Lockheed-Martin.



Program Essentials

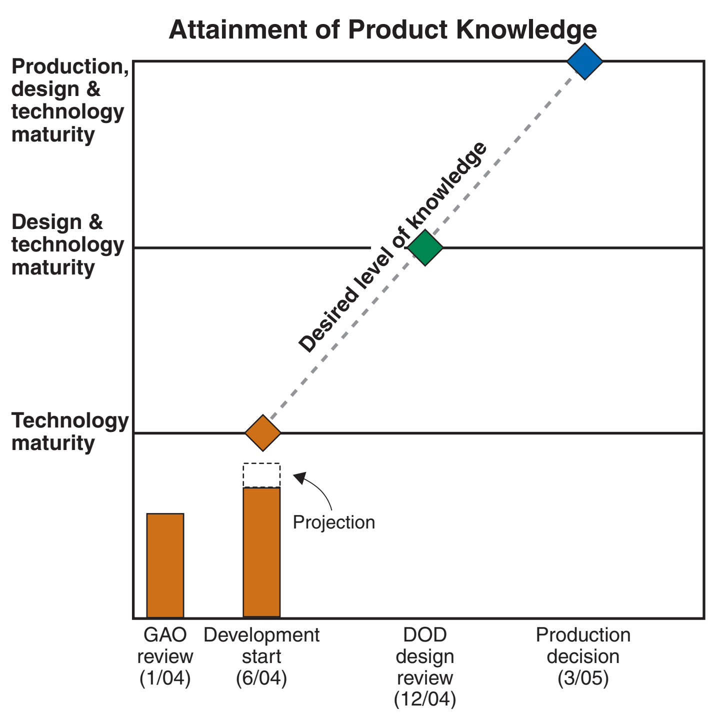
Prime contractor: General Dynamics, Lockheed Martin, Raytheon
Program office: Washington, D.C.
Funding needed to complete:
- R&D: $632.9 million
- Procurement: $208.2 million
- Total funding: $841.1 million
- Procurement quantity: 2

Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 01/2004	Percent change
Research and development cost	NA	$666.5	0.0
Procurement cost	NA	$208.2	0.0
Total program cost	NA	$874.7	0.0
Program unit cost	**NA**	**$437.340**	**0.0**
Total quantities	NA	2	0.0
Acquisition cycle time (months)	NA	31	NA

Data represents a program office estimate for the cost of the first two ships. In the 2004 President's Budget, the funding for the initial two ships and future ships are combined.

The LCS program has 22 mission related critical technologies, and is scheduled to enter system development with 10 of those technologies fully mature. Nine of the remaining 11 technologies will be close to reaching full maturity by the start of system development. The technologies that have not reached maturity affect all 3 of the littoral warfare missions—mine warfare, antisubmarine warfare, and surface warfare.



LCS Program

Technology Maturity

Ten of the 22 critical technologies on LCS will be fully mature at the start of system development. Six technologies are not expected to mature until after the design review.

Four critical technologies act as platforms, which employ other technologies as payloads. These platforms will support operations across the three littoral warfare missions—mine warfare, antisubmarine warfare, and surface warfare. Three of these technologies—the MH-60R, MH-60S, and Vertical Takeoff and Landing Tactical Uninhabited Aerial Vehicle—have reached acceptable levels of technology maturity or they will do so by program development. One technology, the Spartan uninhabited surface vehicle, is not expected to be fully mature until the lead ship award date.

The MH-60R is a helicopter capable of operating as an antisubmarine warfare platform as well as a surface warfare combatant. At the time of our review, the MH-60R and its critical technologies were undergoing technical and operational evaluation for operations in both mission areas.

The MH-60S is a helicopter that will be used in mine warfare and surface warfare missions. At the time of our review the MH-60S in its mine warfare configuration had reached maturity. The technologies used for mine detection have reached maturity, but the technologies used for mine neutralization are not expected to reach maturity by system development. To operate in the surface warfare role, the MH-60S requires structural changes. While the technologies planned for use by the MH-60S in this mission are mature, the MH-60S itself will lack full maturity by system development.

The Vertical Takeoff and Landing Tactical Uninhabited Aerial Vehicle is an uninhabited helicopter originally developed for the role of reconnaissance. For operations with LCS, the vehicle will be integrated with a number of different technologies for operations in littoral warfare missions. To operate as a mine warfare platform, it will utilize the Coastal Battlefield Reconnaissance and Analysis System, a system that is not expected to be fully mature by system development. At the time of our review, no systems had been chosen for operations in the antisubmarine or surface warfare roles.

In contrast to the three aerial platforms, the Spartan is an uninhabited surface vessel. While it was first developed to support reconnaissance, Spartan will be used in all three littoral warfare missions. A prototype of this technology is being tested on deployed naval assets for reconnaissance and force protection functions. These tests should be completed in fiscal year 2004. The technologies that will support other littoral warfare mission will be mature or near maturity at the start of system development, but there is some uncertainty about the complexity of integration with Spartan.

Several additional systems will operate independent of these platforms. These include three uninhabited undersea vehicles for mine warfare that have been used on other naval vessels. Also in development are two distributed sensing systems that will not be mature by system development. A final technology under consideration is Netfires, a missile system being developed by the Army for FCS. This system will not be fully mature by system development. No fallback technologies for any systems have been identified due primarily to the redundant capabilities among the mission modules.

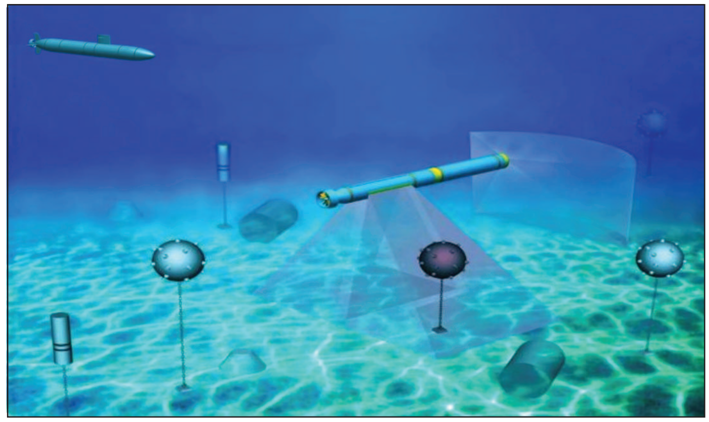
Program Office Comments

In commenting on a draft of this assessment, the program office stated that the first two LCS ships would employ mission modules composed of existing technologies including, but not limited to, those discussed in this report. Future LCS vessels will utilize newly developed mission module packages and will leverage lessons learned from the initial two vessels, including risk mitigation for new technologies such as advanced materials and nontraditional hull types.

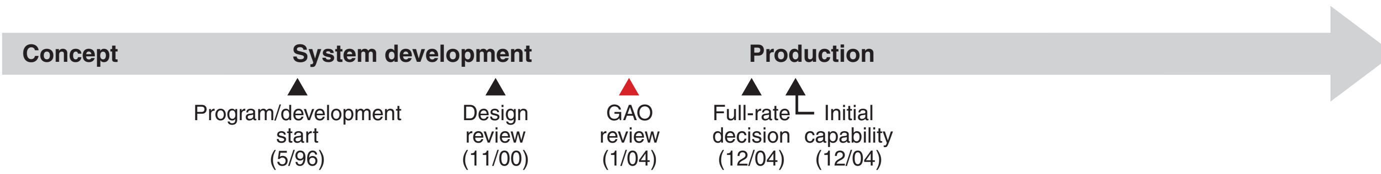
The program office also stated that an important aspect of the LCS program is the development of open interfaces between the ship and the mission modules. LCS modular mission payloads will plug into an open modular architecture through a set of standard systems interfaces. This will mitigate the potential that a single mission package system could negatively affect ship design viability and allow for rapid introduction of new capabilities to the Fleet.

Long-term Mine Reconnaissance System (LMRS)

The Navy's LMRS is a mine reconnaissance system that employs unmanned undersea vehicles. These vehicles are launched and recovered from submarine torpedo tubes. LMRS is designed for autonomous operation to survey potential minefields in support of amphibious and other battle group operations. The Navy plans to obtain 12 operational systems and 1 development system. Each system consists of two unmanned vehicles, ship-deployed command, control and recovery equipment, and shore-based maintenance equipment.



Source: PMS403 Program Office.



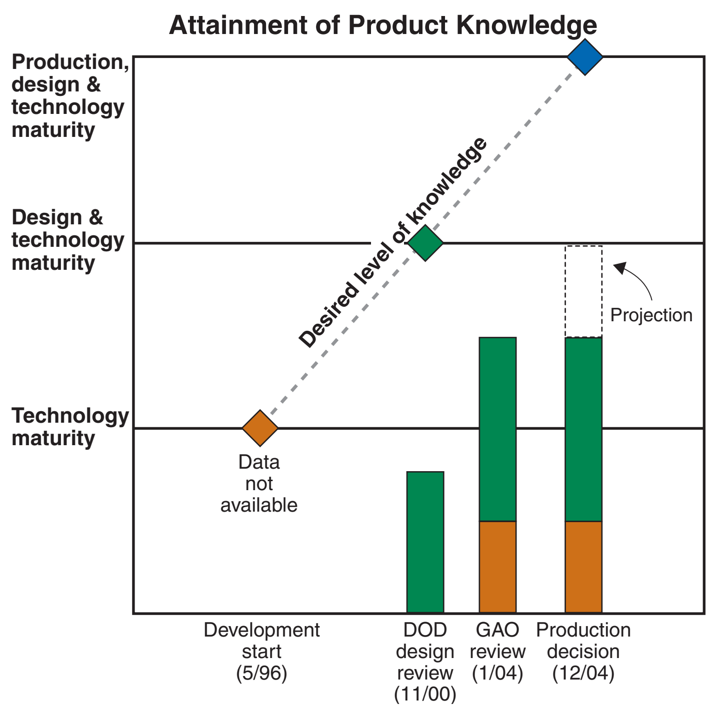
Program Essentials

Prime contractor: Boeing
Program office: Washington D.C.
Funding needed to complete:
R&D: $41.6 million
Procurement: $324.0 million
Total funding: $365.7 million
Procurement quantity: 12

Program Performance (fiscal year 2004 dollars in millions)

	As of 05/1996	Latest 02/2003	Percent change
Research and development cost	$147.5	$233.4	58.2
Procurement cost	$120.0	$323.7	169.7
Total program cost	$267.6	$557.1	108.2
Program unit cost	**$38.223**	**$42.857**	**12.1**
Total quantities	7	13	85.7
Acquisition cycle time (months)	100	103	3.0

The LMRS program began system development with neither of its two critical technologies mature. While progress has been made in the past 7 years, program officials do not expect to achieve maturity on the technologies until July 2004, at the earliest. While the design is currently mature, only about two-thirds of the drawings were complete at the time of the design review. According to program officials, issues with sonar and software development delayed the test program for LMRS. The impact of these delays is being evaluated by the program office.



LMRS Program

Technology Maturity

Neither of LMRS' critical technologies, the sonar suite and the lithium energy system, are fully mature. Program officials expect both technologies to be fully mature by April 2004 and July 2004, respectively. The program began product development in 1996 with both technologies in conceptual form only.

Full technology maturity for the lithium energy system is contingent on receiving a U.S. Navy safety certification so the technology can be tested in an operational environment. Program officials stated that lithium batteries aboard submarines can pose a deadly safety hazard but that it would take a catastrophic incident to release lithium battery byproducts. Program officials indicated that they are taking appropriate actions to reduce this risk to an acceptable level. The lithium energy system is particularly critical as no other technology exists to meet LMRS' endurance requirements.

Design Maturity

The LMRS program's design is mature, with approximately 95 percent of the drawings currently releasable. However, the design was not fully mature at the design review, with only two-thirds of the drawings releasable to manufacturing. Program officials did note that LMRS had developed computer-aided design models by that time in order to assess system agreement with the design.

Program officials told us two significant issues facing the program are sonar and software development. When the program started, sonar development received lower priority and fewer resources compared to other program areas because sonar development was deemed a medium to lower risk. Similarly, at program start, the program office decided not to purchase a software development test set that would have allowed for earlier testing of LMRS software. Although a report summarizing test results is not yet available, program officials informed us that recent tests identified problems with sonar and software development. The program office is evaluating the affect of resulting delays on the program.

Other Program Issues

Future costs are expected to increase. According to program officials, three preplanned product improvements that will enhance LMRS' resolution, range, and identification of mines are scheduled for incorporation into six LMRS units. The cost of these improvements was not included in the latest cost figures from the program office. In addition, delays in sonar development will likely affect the cost and schedule of these improvements.

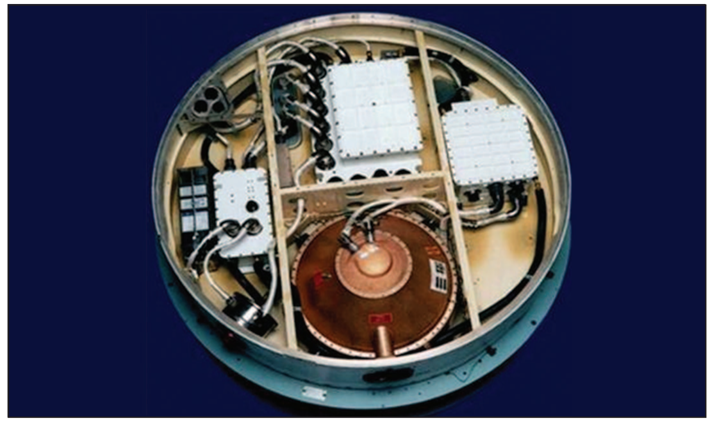
The initial operating capability of LMRS was delayed by approximately 1 year. Work on the program was suspended for 1 year due to a funding mismatch between government funds and contractor requirements. Additionally, cost overruns resulted from unrealistic program projections.

Program Office Comments

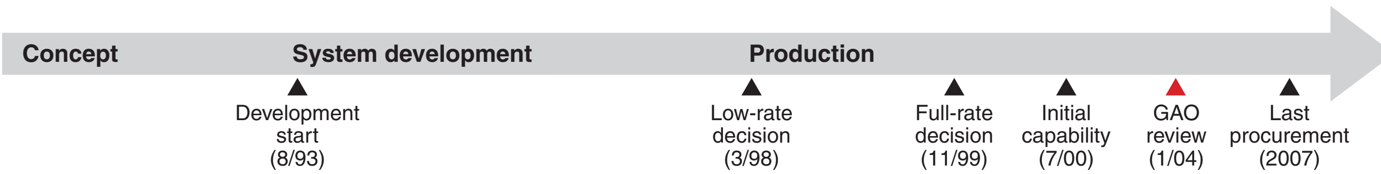
In commenting on a draft of this assessment, the program office stated that the program started as an acquisition streamlining initiative and began with a panel of experts performing a risk assessment. The panel identified five moderate risk areas, including acoustic sensors and energy systems, and no high risk areas. Program officials indicated that risk mitigation plans for the moderate risks were implemented. In the acoustic sensor area, program officials stated that electrical noise and interference problems have delayed development; the effect of this delay is being assessed. Officials indicated that lithium energy batteries are on track to achieve certification to support system test schedules and that all risk areas are undergoing evaluation and are expected to be mitigated to an acceptable level. Program officials also stated that the program cost estimate and schedule for the preplanned product improvements are being assessed in conjunction with the acoustic sensor issue. Program officials emphasized that the program is progressing and will deliver a much needed capability to the warfighter.

Minuteman III Guidance Replacement Program (MM III GRP)

The Air Force's Minuteman III is an intercontinental ballistic missile that can be launched from nuclear-hardened silos located throughout the United States. First deployed in 1970, the system includes the missile, the launch facilities, and the communications network. We assessed the program that is replacing the aging guidance system. This and other life-extension programs are designed to ensure the reliability and supportability of the weapon system through 2020.



Source: ICBM System Program Office - GRP.



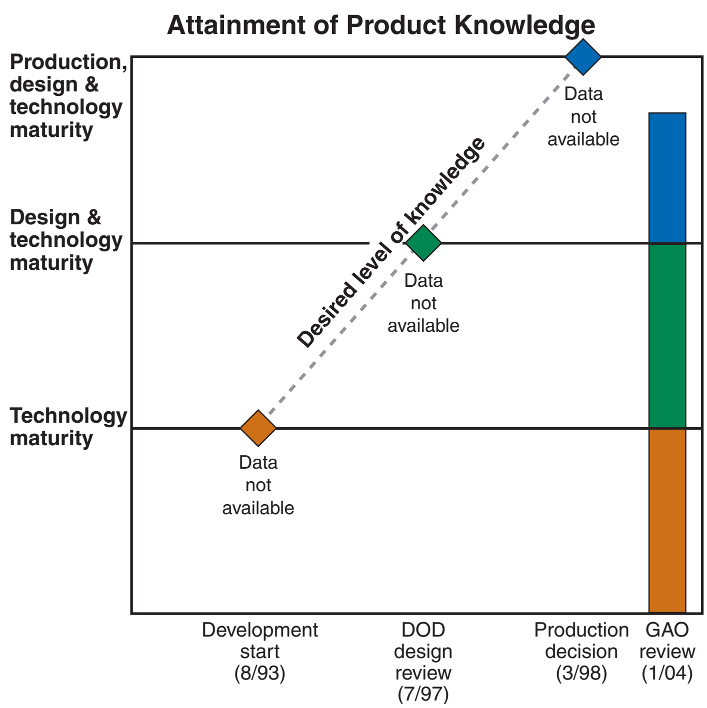
Program Essentials

Prime contractor: Northrop Grumman Mission Systems
Program office: Hill Air Force Base, Utah
Funding needed to complete:
- R&D: $0.0 million
- Procurement: $794.4 million
- Total funding: $794.4 million
- Procurement quantity: 257

Program Performance (fiscal year 2004 dollars in millions)

	As of 08/1993	Latest 09/2003	Percent change
Research and development cost	$494.2	$595.3	20.5
Procurement cost	$1,214.5	$1,938.0	59.6
Total program cost	$1,708.6	$2,533.3	48.3
Program unit cost	**$2.621**	**$3.885**	**48.3**
Total quantities	652	652	0.0
Acquisition cycle time (months)	55	83	50.9

The technology and design of the GRP appear fully mature, and the production appears fairly mature. The program entered full-rate production in November 1999, and it is currently eight sets ahead of its original delivery schedule. This level of maturity follows several years of difficult development. The program's low-rate decision was deferred to 1998 as a result of two restructuring decisions: one in 1995 to reduce program risk from concurrency between program development and production and another in 1997 to analyze design functionality.



MM III GRP Program

Technology Maturity

Although we did not assess technology maturity in detail, the GRP upgrades and extends the life of the 1960s era mature technology used in the Minuteman III guidance system with electronic components that were successfully demonstrated in the commercial sector in the 1990s. The electronics in the guidance system require replacement because current electronic components continue to degrade and are becoming unreliable and unsupportable.

Design Maturity

The GRP's design is mature because the program has released only 25 additional drawings out of 1,600 since production began. Four hardware fixes to the configuration baseline have been implemented in production. All previously produced guidance sets will be brought up to the latest configuration with no impact on the production schedule or cost.

Production Maturity

The program's production processes appear to be fairly mature. Three major production processes use statistical process control measures. Of the eight key subprocesses that are used to monitor these three major production processes, seven use statistical process control data. Five of those seven are meeting the best practice standard. Other production metrics that are used to assess production processes, such as cost of quality (rework), are meeting expectations. As of July 2003, the GRP's production was eight sets ahead of its original fiscal year 1998 baseline delivery schedule. The sets have a performance requirement of 15,000 hours between failures and are averaging 17,000 hours after about 2.3 million hours of operation.

Other Program Issues

Because the main navigation unit—the gyrostabilized platform—was designed and built in the 1960s, the demand for parts required to support the platform has decreased and vendors no longer make the parts. Currently, the repair depot has been using parts from decommissioned Minuteman II and Peacekeeper guidance sets to maintain both the old and new Minuteman III sets. It is important that this problem be resolved since the guidance system needs to stay viable through 2020. However, the latest estimates available indicate that parts may only be available through fiscal year 2008 or 2009. To address this problem, the Air Force will need to identify qualified vendors and provide funding prior to and in sufficient time to avoid any interruptions in parts availability.

Program Office Comments

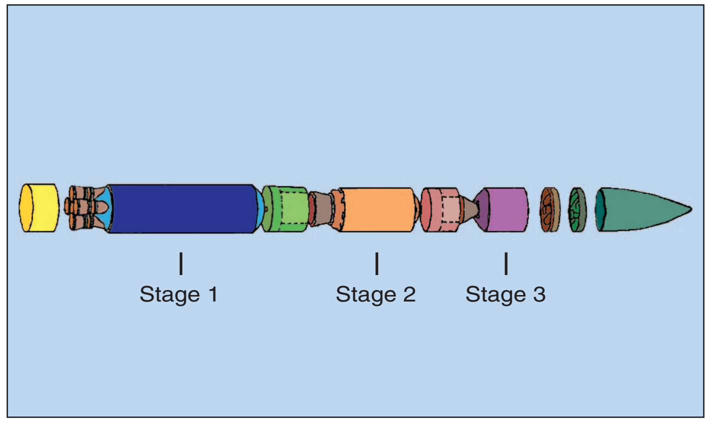
In commenting on a draft of this assessment, program officials noted that total program and unit costs only increased 7.8 percent when compared with the latest approved fiscal year 1999 acquisition program baseline. Program officials also noted that the program is executing its third, fourth, and fifth production options and is currently 1 month ahead of schedule. In addition, the GRP utilizes statistical process control data to measure production processes when possible, but there is also extensive work that does not fit a classical statistical process control format, e.g., cable harness, gyrostabilized platform, and missile guidance set assembly, which are final component assemblies. The program employs learning curve and cost of quality metrics to address these assemblies. The GRP has approved two engineering changes to further streamline the production process and reduce costs. Demonstrated field performance is excellent, according to program officials.

GAO Comments

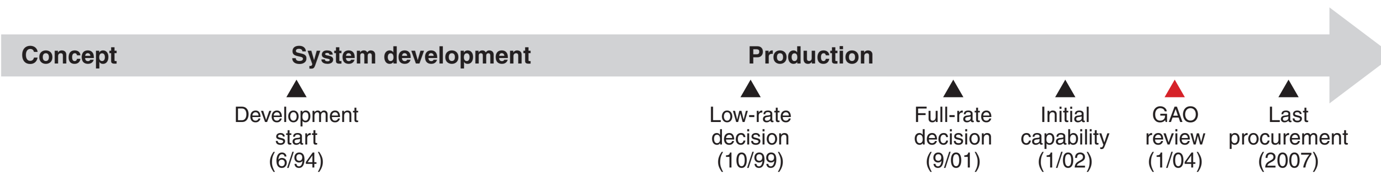
While the program has established a new cost and performance baseline since the August 1993 decision to begin development, the comparison presented provides an accurate picture of change since that major decision. While DOD may subsequently update its baseline for management purposes, our goal is to provide an aggregate or overall picture of a program's history.

Minuteman III Propulsion Replacement Program (MM III PRP)

The Air Force's Minuteman III is an intercontinental ballistic missile that can be launched from nuclear-hardened silos located throughout the United States. First deployed in 1970, the system includes the missile, the launch facilities, and the communications network. We assessed the program's remanufacturing of the missile's three-stage solid-propellant rocket motors. This and other life-extension programs are designed to ensure the reliability and supportability of the weapon system through 2020.



Source: ICBM System Program Office - PRP.



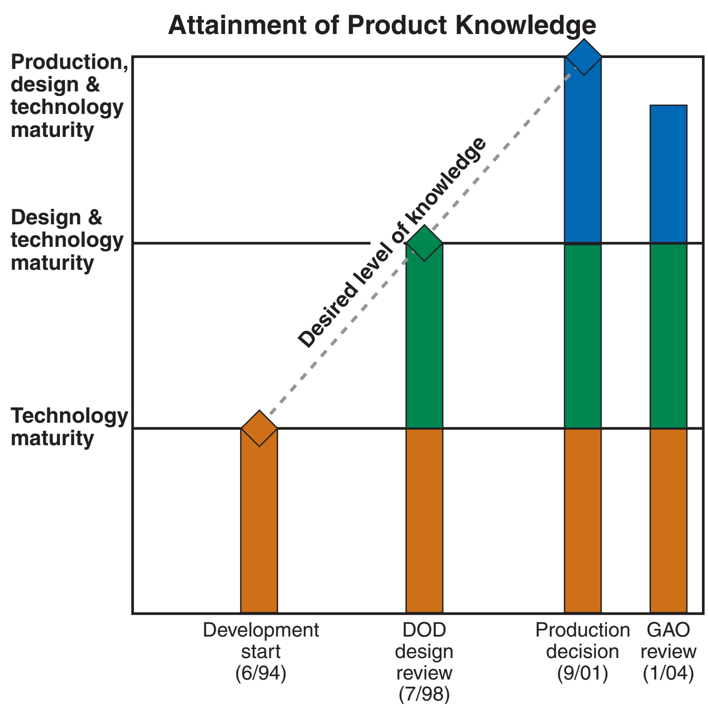
Program Essentials

Prime contractor: Northrop Grumman Mission Systems
Program office: Hill Air Force Base, Utah
Funding needed to complete:
- R&D: $0.0 million
- Procurement: $1,101.3 million
- Total funding: $1,101.3 million
- Procurement quantity: 378

Program Performance (fiscal year 2004 dollars in millions)

	As of 06/1994	Latest 09/2003	Percent change
Research and development cost	$385.4	$352.3	-8.6
Procurement cost	$2,002.7	$1,908.0	-4.7
Total program cost	$2,388.2	$2,260.2	-5.4
Program unit cost	**$3.934**	**$3.761**	**-4.4**
Total quantities	607	601	-1.0
Acquisition cycle time (months)	90	90	0.0

The program currently has three-fourths of its critical production processes under statistical control. Production maturity has deteriorated from the 100 percent that was in control at the September 2001 full-rate production decision due to recent explosions at a subcontractor facility, where the stage 2 and 3 motors are manufactured. Although a new vendor has been requalified for the production of these stages, the program office does not know if the final procurement schedule for fiscal year 2007 can be met. Technology and design of the solid-propellant rocket motors program appear fully mature.



MM III PRP Program

Technology Maturity

The PRP technologies appear mature because the program is using existing commercial technology previously used on the Minuteman III motors. The upgrade involves chemicals that are compliant with current environmental standards.

Design Maturity

The PRP's design is mature because the program released 100 percent of the drawings to manufacturing at the design review in July 1998. Since that time, obsolete production methods, materials, or components have resulted in minor engineering changes to the design. Further stability has been demonstrated by the successful firing of 20 remanufactured motors and the operational launching of 5 Minuteman III missiles using remanufactured motors.

Production Maturity

According to the program office, 75 percent of critical manufacturing processes are in control. In September 2001, 100 percent were in control, but due to recent problems at a subcontractor facility, this number has declined.

Other Program Issues

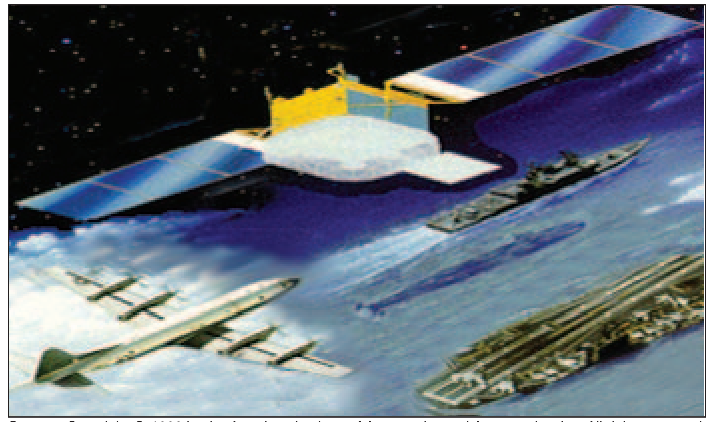
The August and September 2003 explosions are the latest in a series of incidents at the stage 2 and 3 motor remanufacturing facility, including a December 2002 incident in which small lead pellets from a cracked dead blow mallet were found in 12 stage 2 motors and 9 stage 3 motors. In response to the December 2002 incident, a joint independent team of government and industry experts addressed many problems. According to the program office, these problems included a lack of adherence to procedures and a lack of commitment to producing quality products. In response to other incidents, the program office began withholding progress payments until the subcontractor provided a recovery plan to address the problems. Moreover, the program office is now addressing issues through management reviews of the production facility. However, program officials stated that they do not yet know how the latest incidents will affect the critical path of all Minuteman III life extension programs needed to make the weapon system operational through 2020.

Program Office Comments

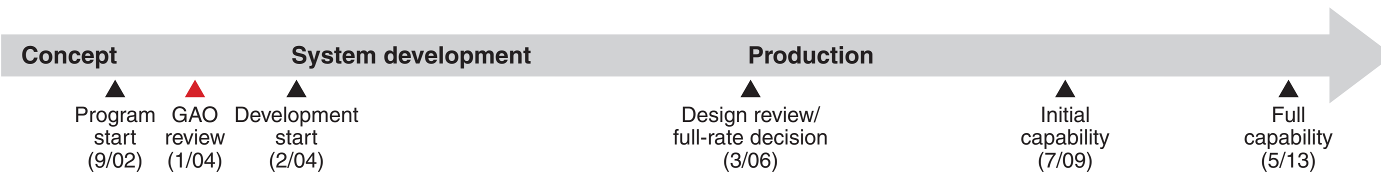
In commenting on a draft of this assessment, the program office generally agreed with the information in this report. Program officials noted that the PRP requalified a new vendor for stage 2 and 3 rocket motor production. The new vendor successfully met its first major milestone involving casting trials. Transitioning the tooling and material from the previous vendor to the new one is on track. The new vendor is expected to reach full-rate production in July 2004. The PRP is mitigating risk to national security by augmenting the remaining production line with spare motor assets to keep rocket motor production moving.

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 being developed to replace the Ultra High Frequency (UHF) Follow-On satellite system currently in operation and is required to support 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.



Note: Image above depicts the Ultra High Frequency (UHF) Follow-On Satellite.



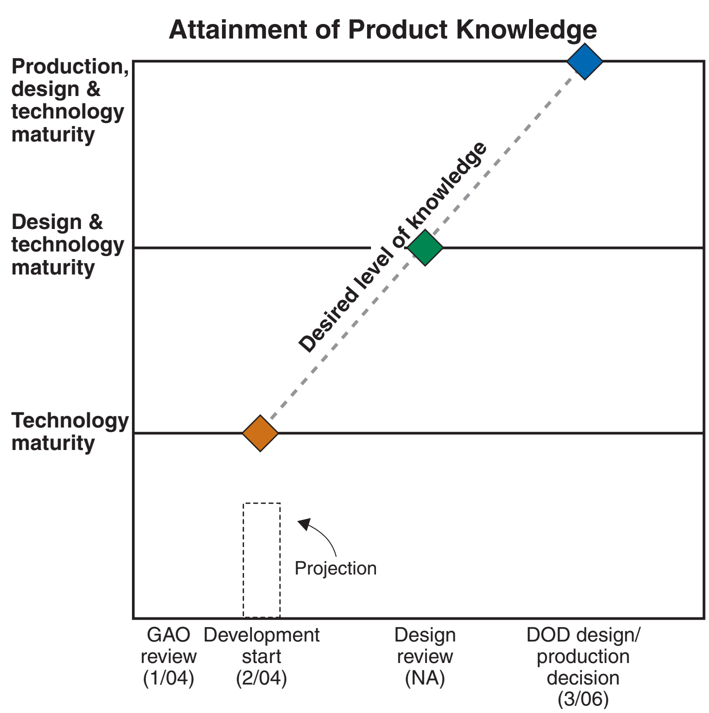
Program Essentials

Prime contractor: Lockheed Martin Space Systems or Raytheon Company
Program office: San Diego, Calif.
Funding needed to complete:
- R&D: $1,421.0 million
- Procurement: $4,052.0 million
- Total funding: $5,651.0 million
- Procurement quantity: 4

Program Performance (fiscal year 2004 dollars in millions)

	As of 12/2002	Latest 01/2004	Percent change
Research and development cost	$1,547.0	$2,845.0	83.9
Procurement cost	$4,054.0	$2,601.0	-35.8
Total program cost	$5,790.0	$5,649.0	-2.4
Program unit cost	**$643.333**	**$941.500**	**46.3**
Total quantities	9	6	-33.3
Acquisition cycle time (months)	69	81	17.4

The MUOS satellite program plans to enter the development phase in February 2004 with five of eight critical technologies mature. The remaining three technologies are projected to be mature by March 2006 in time for the critical design review. Mature backup technologies are available should the new technology fail to mature; however, use of backup technologies could degrade system performance in some key areas. The product development period will likely require concurrent technology maturation and product development activities to maintain schedule.



MUOS Program

Technology Maturity

None of MUOS' eight critical technologies have demonstrated full maturity, although program officials expect five of the eight critical technologies to be mature by the start of the development program in February 2004. The remaining three technologies are expected to be mature by the time the program reaches its critical design review, in March 2006. The eight critical technologies have mature backup technologies in the event that they fail to mature. However, the use of backup technologies could cause MUOS performance to fall below its minimum requirements in some key areas.

The two contractors currently competing for the MOUS program are developing their own unique designs that could be based on different technologies. Therefore, it is possible that a technology now expected to be immature at the start of the development program will not be included in the winning contractor's design. However, due to source selection sensitivity, no specific information regarding either contractors' design or associated program cost could be disclosed.

Design Maturity

The program's acquisition strategy requiring concurrent technology maturation and product development could affect the timely achievement of a stable design. The critical design review is scheduled for March 2006. Until a development contractor is selected, design maturity information is considered source selection sensitive.

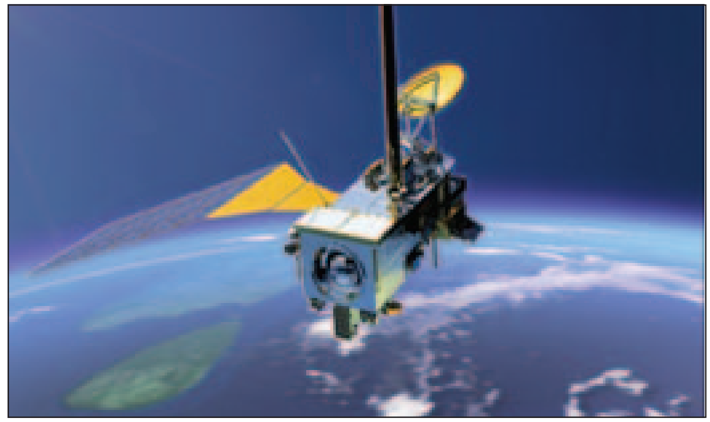
Program Office Comments

In commenting on a draft of this assessment, the program office generally agreed with our characterization of the MUOS program. In response to our concern about concurrent technology maturation and product development, it noted that the initial operational capability was moved out 1 year, which it believes will allow the MUOS contractor more time to mature the necessary technology and finalize the system design.

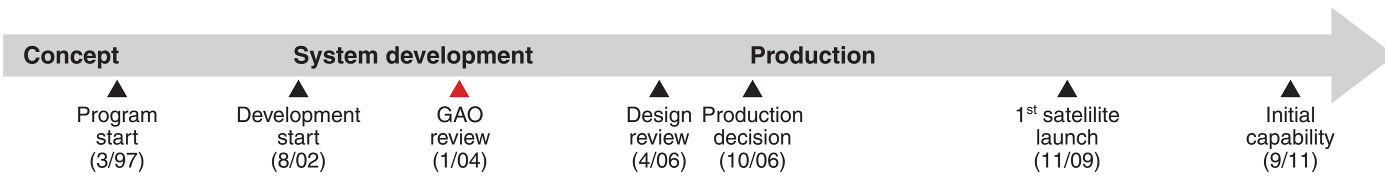
In addition to the comments noted above, technical comments were provided and appropriate changes were made to the assessment.

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 designed to monitor the weather and environment. Current NOAA and DOD satellites will be merged into a single national system with projected savings of at least $1.3 billion. The program consists of five segments: space; command, control, and communications; interface data processing; launch; and system integration. We assessed all segments.



Source: Northrop Grumman.



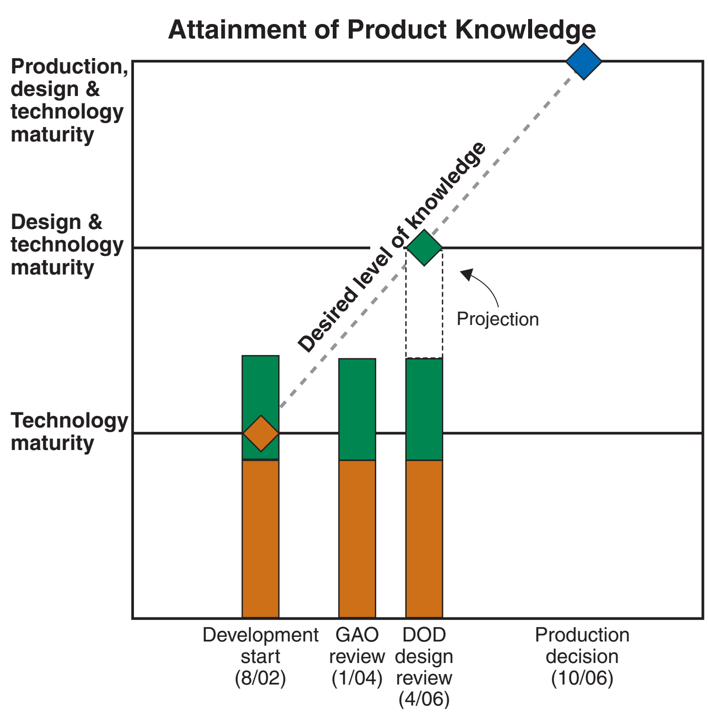
Program Essentials

Prime contractor: Northrop Grumman Space Technology
Program office: Silver Spring, Md.
Funding needed to complete:
- R&D: $3,087.6 million
- Procurement: $1,272.2 million
- Total funding: $4,846.2 million
- Procurement quantity: 4

Program Performance (fiscal year 2004 dollars in millions)

	As of 08/2002	Latest 12/2002	Percent change
Research and development cost	$4,061.0	$4,458.4	9.8
Procurement cost	$1,162.6	$1,272.2	9.4
Total program cost	$5,666.1	$6,217.0	9.7
Program unit cost	**$944.342**	**$1,036.167**	**9.7**
Total quantities	6	6	0.0
Acquisition cycle time (months)	172	172	0.0

The NPOESS program entered system development in August 2002 with 12 of its 14 critical technologies mature. While the total number of design drawings has yet to be determined, the program has completed half the currently identified engineering drawings, well in advance of the design review. Over 5 years ago, program officials considered the program to have several high-risk areas, but since then, officials have taken steps to reduce program risk. One significant step being taken is to demonstrate three critical sensors on a demonstrator satellite to assess how well those sensors work within the context of the overall system. Recently, however, the sensor schedule has slipped and combined with new funding challenges, both design review and first satellite launch have slipped to 2006 and 2009, respectively.



NPOESS Program

Technology Maturity

Twelve of the NPOESS 14 critical technologies were fully mature at the start of development in August 2002. The two technologies that are not mature are needed for two key sensors—the cross-track infrared sounder and the conical microwave imager/sounder. The program projects that all technologies will reach full maturity by the time of the design review in 2006.

The NPOESS program plans to demonstrate three critical sensors in an operational environment through a demonstration satellite that is to be launched in 2006. The sensors to be tested include the visible/infrared imager radiometer suite, the cross-track infrared sounder, and the advanced technology microwave sounder. The program will use the demonstration to provide data processing centers with an early opportunity to work with sensors, ground controls, and data processing systems, thereby incorporating lessons learned into the NPOESS satellites. By July 2003, however, development schedules for these sensors were extended due to performance problems.

Program officials indicated that they achieved maturity on other technologies by concentrating on the early development of key individual sensors. The acquisition strategy focused on maturing key sensor technologies, using individual development contracts structured to demonstrate the maturity of each sensor through a component-level design review prior to the system-level design review.

Design Maturity

Program officials indicated that at least 50 percent of the 6,971 currently identified drawings have been completed and released to manufacturing; however, the total number of engineering drawings has yet to be determined. Program officials project that all currently identifiable drawings will be complete by the system design review in 2006.

Contract Management

In late 2002, DOD extended the launch date of one of its legacy meteorological satellites to 2010, delaying the need for the NPOESS replacement satellites. In view of this, DOD and NOAA reduced their funding for the NPOESS program by about $130 million. Program officials also extended the deployment of the first NPOESS satellite launch about 21 months to November 2009.

The recent funding reductions prompted officials to restructure the NPOESS program. A revised plan was completed in December 2003. Program officials stated that the revised plan will necessitate few design changes for the NPOESS satellites and that any changes will be executable within the current 5-year budget.

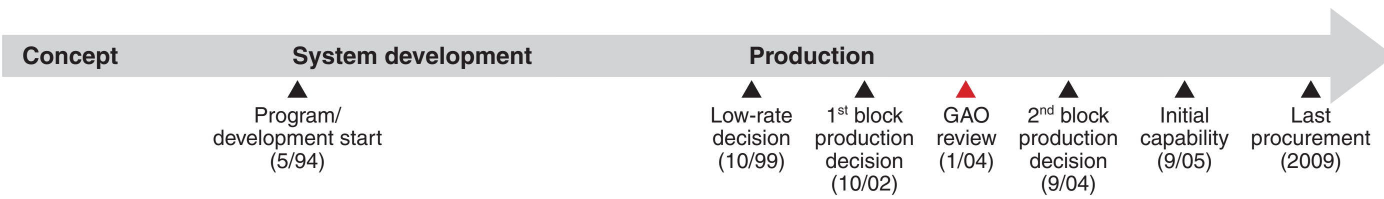
Program Office Comments

The NPOESS integrated program office concurred with this assessment and provided information on updated project milestones and the restructuring plan, which have been incorporated.

Guided Missile System Air Defense (Patriot) PAC-3 Program

The Army's Patriot system is a long-range, high-medium altitude air and missile defense system. The PAC-3 program is designed to enhance the Patriot's ability to detect and identify missiles and other targets, increase system computer capabilities, increase the number of missiles in each launcher, improve communications, and incorporate a new hit-to-kill missile. The PAC-3 system has two primary components, the fire unit and the missile. We assessed both components.

Source: PAC-3 Product Office, Lower Tier Project Office.



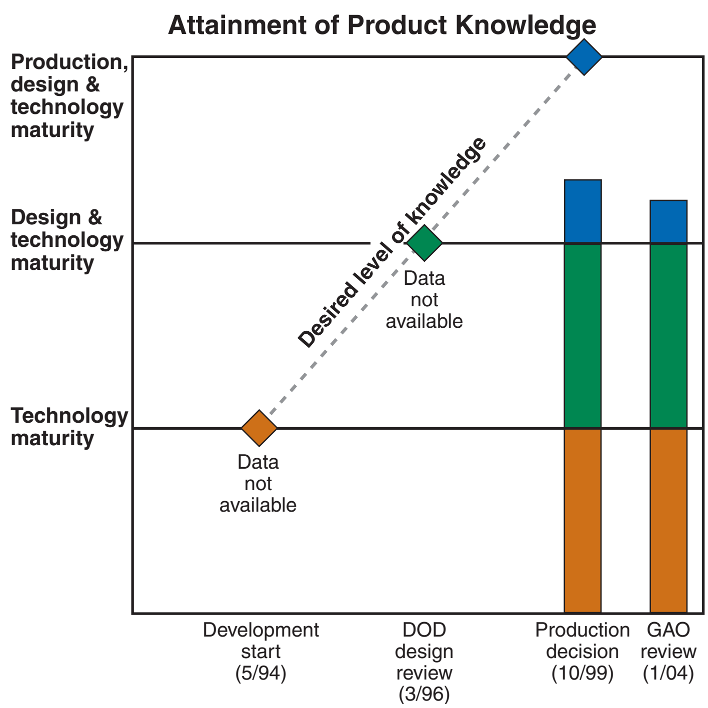
Program Essentials

Prime contractor: Raytheon (prime), Lockheed Martin (missile)
Program office: Huntsville, Ala.
Funding needed to complete:
- R&D: $379.2 million
- Procurement: $4,049.2 million
- Total funding: $4,428.4 million
- Procurement quantity: 1,281

Program Performance (fiscal year 2004 dollars in millions)

	As of 02/1995	Latest 10/2003	Percent change
Research and development cost	$2,830.0	$4,513.0	59.5
Procurement cost	$3,907.7	$8,446.8	116.2
Total program cost	$6,737.7	$12,959.8	92.3
Program unit cost	**$5.615**	**$10.117**	**80.2**
Total quantities	1,200	1,281	6.8
Acquisition cycle time (months)	66	135	104.5

The PAC-3 program continues to report that only a limited number of critical production processes are under control, causing production and testing problems. The technologies and design are stable on the existing system. The Army will award a new contract in 2004 for an additional 135 missiles. These missiles incorporate three alternative technologies that will either reduce the missile's production cost or increase its capability. These technologies have not yet reached full maturity.



Patriot PAC-3 Program

Technology Maturity

Although the PAC-3's critical technologies appear mature, the program office plans to incorporate three alternative technologies into the missile under the fiscal year 2004 production contract. These technologies are not yet fully mature. The advanced master frequency generator and the simplified inertial measurement unit are intended to offer lower cost than current components through the use of common commercial off-the-shelf components. The multi-band radio frequency down link will provide added capability for the missile at a higher unit cost. Each of these alternative technologies is scheduled for environment qualification and missile level ground testing between March and April 2004. Flight-testing is scheduled between April and September 2004. Should these new technologies fail to mature, program officials said they could stay with existing technology.

Design Maturity

The PAC-3's basic design is complete, with 100 percent of the drawings released to manufacturing. However, as a result of the technology insertion program, funded under the fiscal year 2004 production contract, there will be an additional 103 drawings. Of the 103 total drawings, 75 have been released thus far. The remaining drawings will be released between March and April 2004.

Production Maturity

The program has 23 percent of the key manufacturing processes used to assemble the missile and the seeker under control. Significant improvement in bringing additional processes under control has not occurred, and production and testing problems remain. However, program officials noted that rework needed before the seeker passes inspection has decreased from an average of about three times to less than two times within the past year.

Proposals are being considered from Lockheed to convert the fiscal year 2002 and 2003 contracts from fixed price incentive to firm fixed price. A new contract for fiscal year 2004 production is projected to be awarded by December 2003.

Other Program Issues

On July 29, 2003, the PAC-3 and Medium Extended Air Defense System (MEADS) programs were combined. MEADS, which will use the PAC-3 missile, is designed to be more mobile on the battlefield. The combined system is intended to provide a more robust capability against theater ballistic and cruise missiles, unmanned aerial vehicles, and rotary-and fixed-wing threats. MEADS is scheduled to be deployed in 2012.

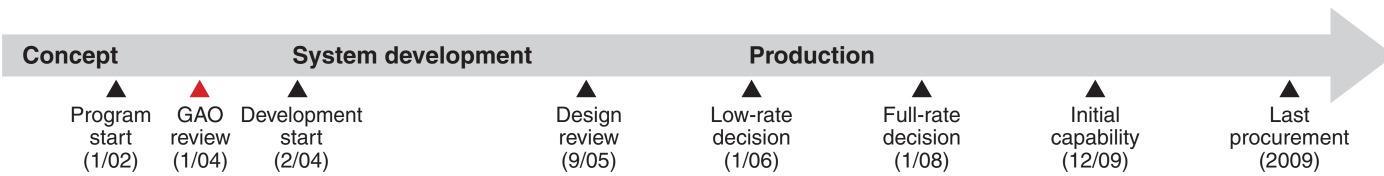
Program Office Comments

The Patriot PAC-3 program office concurred with this assessment.

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 and will employ fused multispectral sensors to find and track small ground mobile or fixed targets. As envisioned, each Predator B system will consist of four aircraft, a ground control station, and a satellite communications suite operated by 55 military personnel.

Source: General Atomics-Aeronautical Systems, Incorporated.



Program Essentials

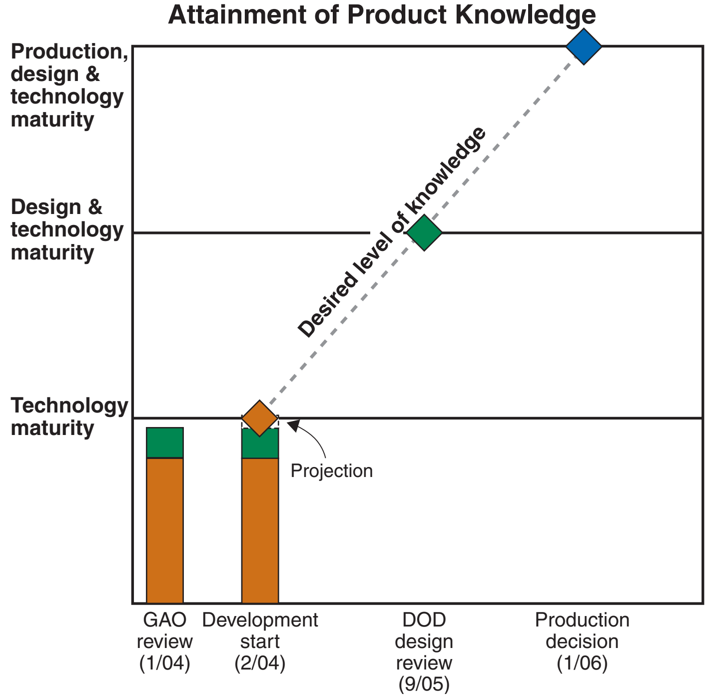
Prime contractor: General Atomics Aeronautical Systems Incorporated
Program office: Dayton, Ohio
Funding needed to complete:
- R&D: TBD
- Procurement: TBD
- Total funding: TBD
- Procurement quantity: 49

Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 10/2003	Percent change
Research and development cost	NA	$214.0	0.0
Procurement cost	NA	$450.2	0.0
Total program cost	NA	$664.1	0.0
Program unit cost	**NA**	**$10.712**	**0.0**
Total quantities	NA	62	0.0
Acquisition cycle time (months)	NA	71	NA

The Predator B is scheduled to enter system development with three of its four critical technologies mature. The fourth technology is comprised of several off-the-shelf components and is expected to be mature by July 2004. Unlike the other technologies, no backup is available in the event this critical technology fails to mature as expected.

Attainment of Product Knowledge



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 one immature technology is the stores management system. This system, which is an avionics subsystem designed to integrate and store data necessary to launch munitions, is currently being evaluated in a laboratory environment. Program officials expect this technology will be ready by July 2004. They believe there is low risk associated with this technology since it is comprised of off-the-shelf components. However, they did acknowledge that no backup technology is available at this time.

Design Maturity

By the start of system development, the program office expects about 22 percent of its engineering drawings, which reflect the aircraft's baseline configuration, will be released. Further, it projects 91 percent of the drawings will be complete and released to manufacturing by the September 2005 critical design review. The program office believes the current design benefits from incorporating several common components from the Predator A aircraft and the current design and development of two prototype Predator B aircraft.

Production Maturity

According to program officials, the contractor does not plan to use statistical process control techniques. Instead, the contractor plans to use other quality control techniques such as scrap, rework, and repair to track and measure the quality of its manufacturing processes. We have found this approach reactive versus prospective and may result in cost and schedule increases.

Other Program Issues

Recent changes to the Predator B acquisition strategy may create additional program risks. In July 2003, at the direction of Air Force headquarters, the Predator B acquisition approach was changed to standardize the development process. This, along with recent budget cuts, caused program officials to consider how best to restructure the program. The Air Force had planned to procure 62 aircraft through 2009. Program officials are now considering a plan to procure the 62 aircraft through 2014, 5 years longer than the original plan. Program risk assessments are underway to prioritize and match user requirements with program resources. No final decisions will be made until early 2004.

Because of altitude limitations, the Army's Hellfire laser-guided missile is no longer the weapon of choice for the Predator B. The Air Force is considering other lightweight munitions.

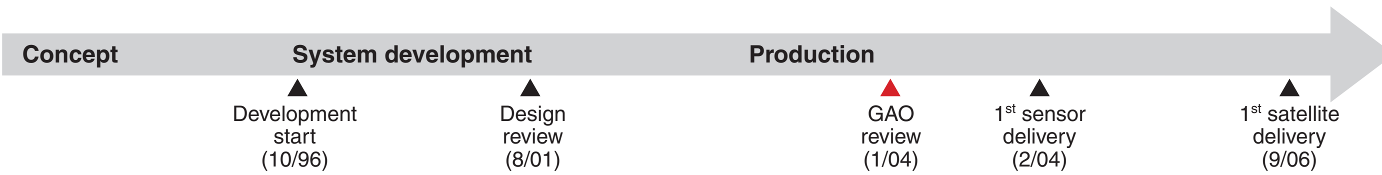
Program Office Comments

In commenting on a draft of this assessment, the program office acknowledged it did not contractually require collection of statistical process control data on critical manufacturing processes. Program officials stated that their program strategy to demonstrate manufacturing process maturity includes building, testing, and evaluating production representative aircraft; conducting multiple readiness reviews; and utilizing low-rate initial production to test production processes. The contractor is also performing statistical data analyses on nonconformance items, defects, unscheduled depot returns, and supplier performance. Program officials also stated the system user is reassessing the Predator B system profile. The Predator B's modular, open-ended design has resulted in operational improvements and may no longer require a system of four aircraft. Thus, the actual number of aircraft, supporting equipment, and personnel needed to support a Predator B system has yet to be determined.

Space Based Infrared System (SBIRS) High

The Air Force's SBIRS High program is a satellite system intended to provide missile warning information and to support the missile defense, technical intelligence, and battlespace characterization missions. It is intended to replace the Defense Support Program and will consist of four satellites (plus one spare) in geosynchronous earth orbit (GEO), two sensors on host satellites in highly elliptical orbit (HEO), and associated ground stations. Our assessment discusses the sensors and satellites only.

Source: Lockheed Martin Space Systems Company.



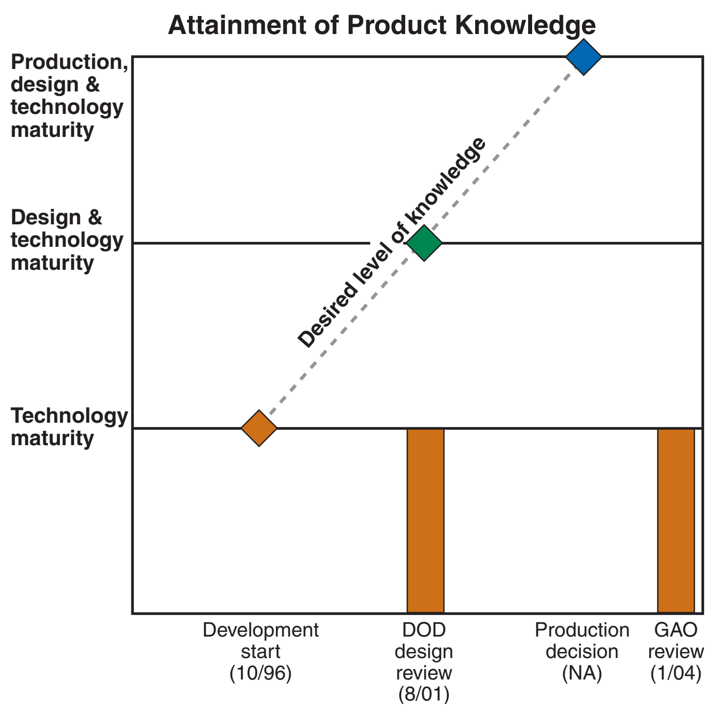
Program Essentials

Prime contractor: Lockheed Martin Space Systems Company
Program office: El Segundo, Calif.
Funding needed to complete:
- R&D: $2,677.0 million
- Procurement: $1,358.3 million
- Total funding: $4,603.0 million
- Procurement quantity: 3

Program Performance (fiscal year 2004 dollars in millions)

	As of 03/1998	Latest 09/2003	Percent change
Research and development cost	$3,387.9	$6,368.1	88.0
Procurement cost	$557.8	$1,358.3	143.5
Total program cost	$4,132.4	$8,462.7	104.8
Program unit cost	**$826.482**	**$1,692.543**	**104.8**
Total quantities	5	5	0.0
Acquisition cycle time (months)	86	147	70.9

The SBIRS High program's critical technologies have demonstrated acceptable levels of maturity after many years of difficult development. The level of design stability is unknown since the contractor was unable to provide information on the total number of releasable drawings. Similarly, production maturity could not be determined because the contractor does not collect statistical control data. In August 2002, the program underwent a major restructuring after program costs increased to the point of triggering a departmental-level review. Though corrective measures have been taken, the program is still beset with technical problems and scheduling delays.



SBIRS High Program

Technology Maturity

The SBIRS High program's three critical technologies—the infrared sensor, thermal management, and onboard processor—are mature. Program officials indicated that the hardware was built and tested in a thermal vacuum chamber under expected flight conditions. These technologies were not mature at the start of development.

Design Maturity

The SBIRS High design was immature at the time of the design review. Less that 50 percent of the current drawings had been released at that time. We could not assess the program's current design stability because program officials do not know how many total design drawings are expected for the program.

Design stability has been an issue for SBIRS High. The delivery of the first HEO sensor has been delayed over 12 months since the program was restructured in August 2002, due to excessive electromagnetic interference (radio waves emitted by the sensor's electronics that interfere with the host satellite). The first HEO sensor is now scheduled for delivery in February 2004.

The program office has reported that it is applying the knowledge gained from the design problems on this sensor to the second HEO sensor which is now due for delivery in June 2004—a 5-month delay from the restructured schedule.

Production Maturity

We could not assess the production maturity of SBIRS High because the contractor does not collect statistical process control data. However, the program office does track and assess production maturity through detailed monthly manufacturing and test data and monthly updates on flight hardware qualifications. According to the program office, these updates continue to reveal acceptable results.

Other Program Issues

The delayed delivery of the first of two HEO sensors will likely have long-term consequences for the remainder of the program. For example, resources needed for the second HEO sensor and GEO satellites were pulled and used on the first HEO sensor. As a result, the program will likely encounter additional delays.

The Air Force has decided to purchase two additional HEO sensors for constellation replenishment but has yet to fund them. Its current acquisition strategy is to procure them separately at an estimated cost of $314 million for the third HEO sensor and $237 million for the fourth. In addition, the Air Force had considered accelerating the schedules for the last three GEO satellites after concerns were expressed by Congress over plans to delay these acquisitions. The Air Force has now determined not to accelerate the GEO production schedule and that the right time to begin procurement of these satellites is in fiscal year 2006 (it plans to include $1.3 billion for this purpose in fiscal years 2006 and 2007 budget requests). The Air Force believes this schedule provides the optimal balance among concurrency, operational needs, and industrial base sustainment.

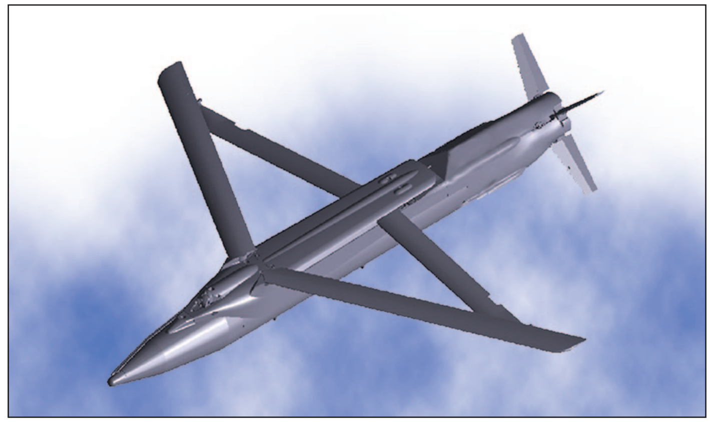
Program Office Comments

In commenting on a draft of this assessment, the program office stated that as part of the restructure activities, the program office instituted incentive fees for cost performance, rigorous management mechanisms to improve program stability and executability, and increased senior-level oversight. It also continues to focus on minimizing the downstream effects resulting from the initial program shortcomings.

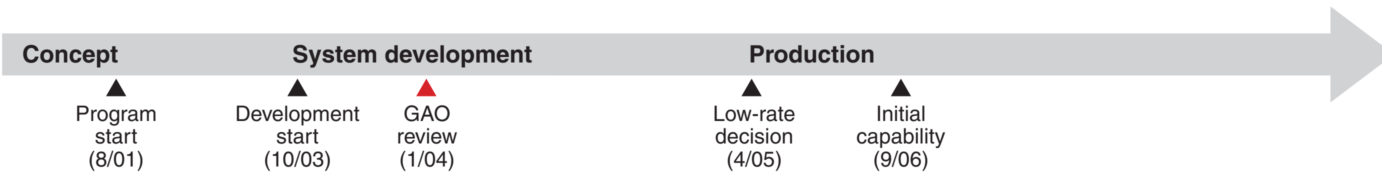
Additionally, program officials agreed that the difficulties encountered on the HEO sensor have added pressure to the overall SBIRS High schedule, but they noted that the program office is committed to stabilizing requirements by following disciplined processes and continues to assess and mitigate, when possible, cost and schedule risks. Despite these changes, program officials project that SBIRS High will continue to face the consequences associated with earlier program decisions for several more years, but they asserted that the program remains postured to identify and respond to them within the current budget.

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 accommodate integration with other aircraft, such as the F/A-22. Potential follow-on capabilities, such as precision strike against moving targets, are being considered.



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



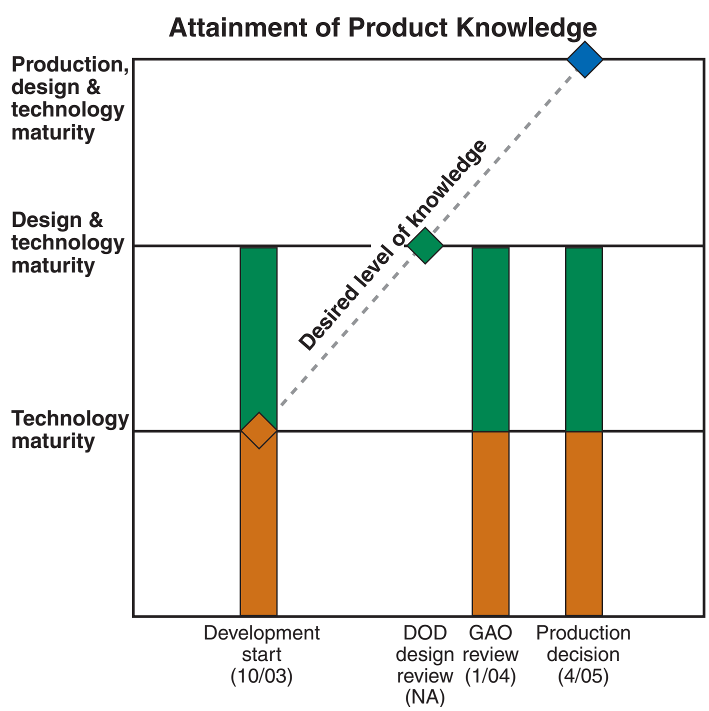
Program Essentials

Prime contractor: Boeing
Program office: Fort Walton Beach, Fla.
Funding to complete through 2009:
- R&D: $260.8 million
- Procurement: $379.0 million
- Total funding: $639.9 million
- Procurement quantity: 24,000

Program Performance (fiscal year 2004 dollars in millions)

	As of 10/2003	Latest 10/2003	Percent change
Research and development cost	$377.8	$377.8	0.0
Procurement cost	$1,196.1	$1,196.1	0.0
Total program cost	$1,573.8	$1,573.8	0.0
Program unit cost	**$0.065**	**$0.065**	**0.0**
Total quantities	24,070	24,070	0.0
Acquisition cycle time (months)	61	61	0.0

The program office assessed all eight critical technologies for the SDB as mature. The program office held the design review prior to starting system development and, although data was not collected, the program maintains that the contractor released over 90 percent of the production drawings prior to system development. Beginning in 2004, the program will begin its seamless verification test program, which combines developmental, live fire, and operational testing, in an effort to decrease time spent in system development. This concurrent approach may increase program risks.



SDB Program

Technology Maturity

The program office assessed all eight critical technologies for the SDB as mature. Program officials stated that many of the critical technologies have been demonstrated in a free-flight environment. They also stated that they have flight tested the system with the properly sized components.

Design Maturity

The program office held the design review prior to the start of system development. Also, although data was not accumulated, the program office maintains that Boeing released over 90 percent of the production drawings prior to system development. According to the program office, although the contractor has ultimate responsibility for the weapon system and has given the government a 20-year 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 plans to combine developmental, live fire, and operational testing beginning in 2004, and early test objectives will be primarily defined by the contractor. It believes this combined testing will eliminate or reduce redundant testing. This process could expose the program to additional risk, as there may be more concurrency between system developmental and operational tests.

Program Office Comments

In commenting on a draft of this assessment, the program office stated that the SDB program concluded a highly successful source selection with a preproduction weapon that met all requirements. Program officials also noted that the 2-year competition achieved the following: design reviews completed; early live fire tests conducted; over 80 percent production representative hardware flown; and Boeing conducted six SDB free flights. This maturity resulted in a budgeted average unit production price below the program objective goal with significant savings to the government.
A seamless verification test program was designed to involve the operational community earlier in the test process, reduce the test schedule and assets, and meet requirements. SDB is on track to meet its production decision, 18 months after system development, and meet its 2006 fielding date.

RQ-7A Shadow 200 Unmanned Aerial Vehicle System (Shadow 200)

The Army's Shadow system is intended to be a ground commander's reconnaissance, surveillance, target acquisition, and battle damage assessment system. The system is comprised of four air vehicles, payloads, ground control stations, launch and recovery equipment, and communications equipment. The small, lightweight air vehicle is intended to provide up to 4 hours of operations at 50 kilometers from the launch and recovery site. The program entered product development and limited production simultaneously in December 1999.

Source: AAI Corporation.

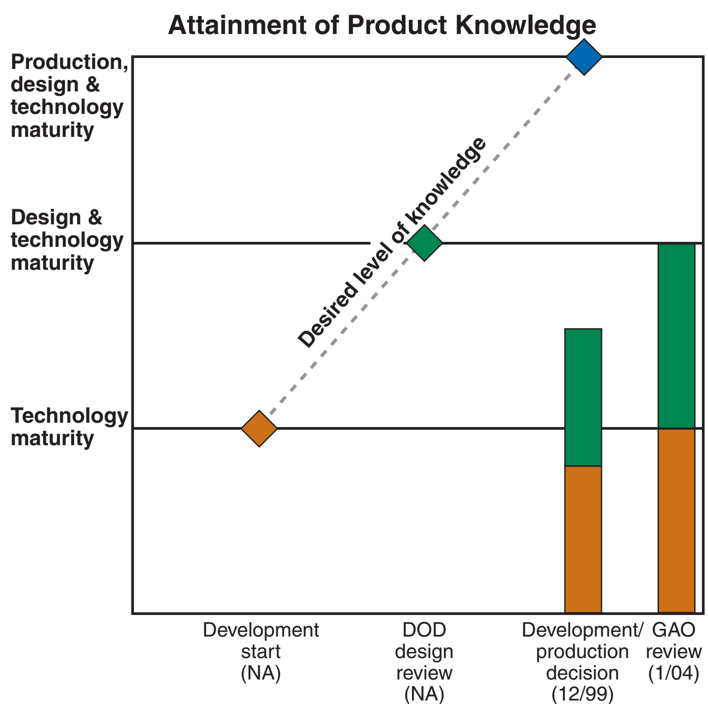
Program Essentials

Prime contractor: AAI Corporation
Program office: Huntsville, Ala.
Funding needed to complete:
- R&D: $71.0 million
- Procurement: $266.2 million
- Total funding: $344.6 million
- Procurement quantity: 19

Program Performance (fiscal year 2004 dollars in millions)

	As of 12/1999	Latest 09/2003	Percent change
Research and development cost	$193.2	$271.5	40.5
Procurement cost	$436.0	$498.1	14.3
Total program cost	$629.2	$777.1	23.5
Program unit cost	**$14.299**	**$18.953**	**32.5**
Total quantities	44	41	-6.8
Acquisition cycle time (months)	51	43	-15.7

The Shadow program's technology is mature and the basic design is complete. However, the program began production in December 1999 before achieving design stability or production maturity. Because the design was not mature, testing revealed product reliability problems, delaying operational testing and the full-rate production decision. The contractor only recently started to capture statistical control data on its manufacturing processes. Despite resultant cost increases and operational shortfalls, the Army was still able to quickly deliver a needed capability to the warfighter that has been used during recent operations.



Shadow 200 Program

Technology Maturity

All of the Shadow's critical technologies are mature because they have been demonstrated using actual hardware in realistic conditions. At the limited production decision, which coincided with product development start, four of the five technologies critical to the system's performance were considered mature. The one immature technology, task automation, is now considered mature. Prior to limited production, a representative air vehicle was flown and evaluated to demonstrate feasibility before a commitment to limited production was made. It was not until about 3 years later that the last technology reached maturity.

Design Maturity

The basic design of the Shadow is now complete. However, the design was not considered stable when it entered low-rate production. At that time, the program had completed 67 percent of the drawings. Subsequent testing revealed examples of design immaturity, especially relating to the reliability of the system. Early testing revealed significant problems. For example, testing revealed problems with the air vehicle alternator and fuel bladders that resulted in restrictions on the endurance and altitudes that could be flown. An immature design and testing delays caused the Army to postpone its decision to enter full-rate production by about 6 months from that planned at the low-rate production decision.

Production Maturity

According to the program office, the contractor only recently started to track statistical control data for its critical manufacturing processes. As a result, the program entered full-rate production in September 2002 without ensuring that manufacturing processes were mature. The program did conduct a production readiness review that identified some low- to moderate-risk areas but concluded the contractor could successfully execute the full-rate production contract.

The delay in achieving design maturity affected attainment of production knowledge and delayed operational testing. Problems encountered during early tests forced the program to delay the completion of operational testing by about 1 year. The Director of Operational Test and Evaluation reported in December 2002 that the Shadow was not operationally suitable, survivable, and may not be affordable. During operational tests, the system did not meet its reliability or maintainability requirements. The Army decided to field the system as is, rather than meeting 100 percent of the operational requirements. Since the beginning of the program, it has been recognized that deficiencies would exist and would be corrected through subsequent block upgrades. However, the lack of funding has deferred some of these improvements. As of December 2003, 12 systems (48 air vehicles) had been fielded, and according to Army leadership, the Shadow has provided critical intelligence during operations in Iraq.

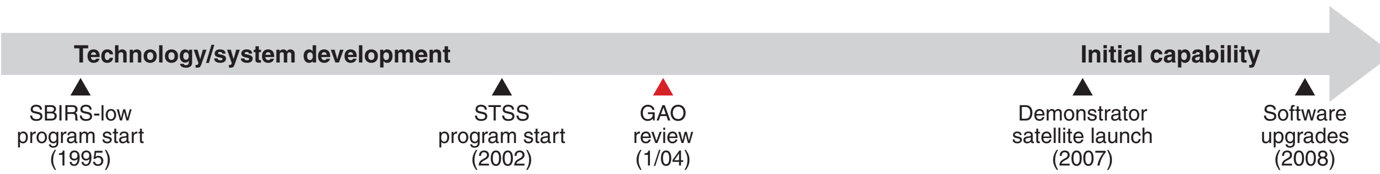
Program Office Comments

In commenting on a draft of this assessment, the program office stated that the Army's requirement was to field an unmanned aerial vehicle system as quickly as possible. It was understood the system would be modified in production to achieve a time-phased incorporation of objective and growth capabilities. The program entered engineering and manufacturing development and low-rate initial production in December 1999. The program received a successful full-rate production decision in September 2002. The successful full-rate production decision is a first for any DOD unmanned aerial vehicle program and was accomplished in only 33 months. To date, 12 systems have been fielded, including 4 to Operation Iraqi Freedom, which are operating at five to six times their peacetime operational tempo. The systems are receiving outstanding feedback from the field, and commanders are requesting that fieldings be expedited. The Army considers the program and its acquisition strategy successful.

Space Tracking and Surveillance System (STSS)

STSS is being developed in incremental, capability-based blocks designed to track missiles throughout their flight. The initial increment is composed of two demonstration satellites built under the Space-Based Infrared System-low (SBIRS-low) program. MDA plans to launch these satellites in 2007 to assess how well they work within the context of the missile defense program. MDA may also develop a new constellation of satellites and plans to launch the first of these in 2011. We assessed the two demonstration satellites.

Source: STSS Program Brief.



Program Essentials

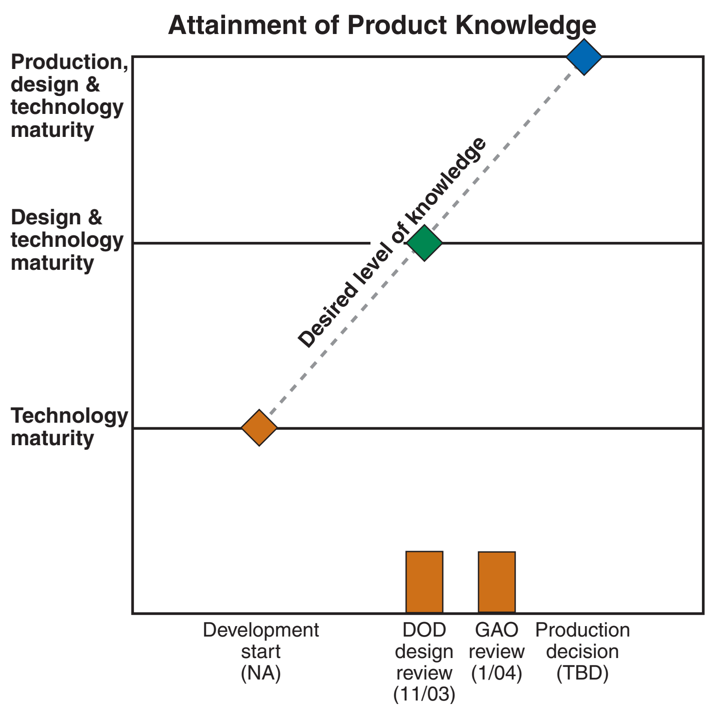
Prime contractor: Northrop Grumman Space Technology
Program office: El Segundo, Calif.
Funding to complete through 2009:
- R&D: $3,970.4 million
- Procurement: $0.0 million
- Total funding: $3,970.4 million
- Procurement quantity: 0

Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 02/2003	Percent change
Research and development cost	NA	$6,122.6	0.0
Procurement cost	NA	$0.0	0.0
Total program cost	NA	$6,122.6	0.0
Program unit cost	**NA**	**$3,061.310**	**0.0**
Total quantities	NA	2	0.0
Acquisition cycle time (months)	TBD	TBD	TBD

Latest cost includes all costs from the program's inception through fiscal year 2009. Procurement funding and quantities have yet to be determined. NA = not applicable

Only two of the initial STSS increment's six critical technologies have reached an acceptable level of maturity, two are expected to reach maturity in September 2004, and the remaining two are not expected to reach full maturity until June 2006—1 year prior to launch. We could not assess the design or production maturity, as there was no data available from the program office. The initial STSS increment demonstration satellites were partially built under the previous SBIRS-low effort and put into storage 5 years ago. SBIRS-low was stopped after the Air Force encountered significant cost and scheduling increases and spent nearly $1.7 billion without launching a single satellite. Prior to launch, the program must complete testing on the satellite components and perform assembly, integration, and system level testing activities.



STSS Program

Technology Maturity

Only two of six critical technologies—satellite communication cross-links and on-board processor—are nearing maturity. Of the remaining four technologies, the acquisition sensor and the tracking sensor are expected to reach maturity by September 2004 and the single-stage cryocooler and the two-stage cryocooler are not expected to achieve maturity until June 2006, about 1 year before the satellites are to be launched.

Design Maturity

We did not assess the design maturity of the STSS demonstrator satellites because drawing release data was not available. The program currently has prototypes for the two mature technologies.

To launch the satellites, the STSS program must address certain risk areas. Some of these areas include assessing the working condition of the satellite hardware and software; dealing with insufficient time to complete the ground segment, payload, and infrared software development and testing; analyzing critical tests for acceptable performance prior to launch; making modifications to the tracking sensor; and handling issues related to parts obsolescence. The program faces other challenges to get the satellites ready for launch within budget and on schedule. A number of space segment design activities are still needed for the existing satellite hardware and are proving to be more complex or require more effort than originally planned. In addition, the payload subcontractor has had a number of program management and quality process problems that have led to delays in developing the software and the upgrades to improve tracking sensor performance.

Other Program Issues

Neither the prime contractor nor the payload subcontractor has demonstrated a consistent ability to identify and correct problems without strong program office involvement. The program office stated that it has frequently taken steps to ensure the quality control of this program.

The STSS program also includes plans for developing a new constellation of missile tracking satellites in support of the ballistic missile defense system. The new satellites could be different and more capable than the ones to be launched in 2007. This part of the program is still in a conceptual stage. MDA plans to start work on the new constellation of satellites in 2005 or 2006 and launch a demonstrator satellite in 2011. The satellites are to serve as a baseline for follow-on satellites that will comprise the STSS constellation.

We reported in May 2003, that by pursuing efforts to get the existing satellites ready for launch in 2007, MDA may be missing an opportunity to spend more time and money developing technologies needed for the new constellation of satellites. Further, by focusing on the newer constellation of satellites, MDA could launch the first new satellite earlier than 2011 as now planned.

Program Office Comments

In commenting on a draft of this assessment, the program office stated that the remaining work to mature the four technologies is to integrate the various components into the satellite end-item system. Program officials further noted that most of the design difficulties relate to improving tracking sensor performance and accommodating the launch of the two satellites on a single booster. With the completion of a system critical design review in November 2003, they believe these design issues are behind them and should not cause any further significant variances. Additionally, program officials noted that they and the prime contractor have had a relationship that has not required any more program office intervention than originally envisioned. Finally, they stated that MDA had considered other alternatives to launching the existing satellites but found them not to be prudent in the context of the overall ballistic missile defense system.

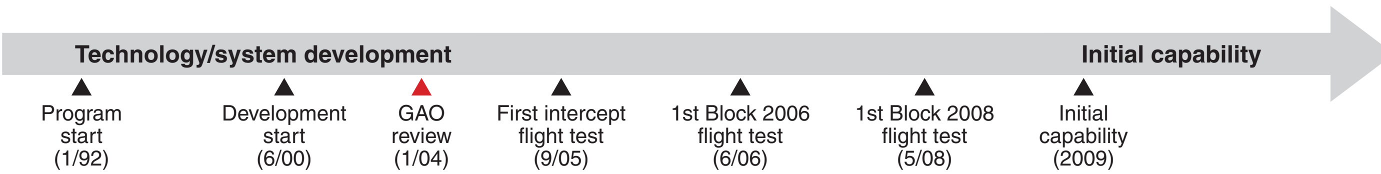
GAO Comments

Our prior work has shown that MDA's assessment of alternatives to launching the demonstration satellites did not fully consider the option of focusing solely on development of new technology, which could offer operational capability sooner.

Theater 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. This system is designed to protect forward-deployed military forces, population centers, and civilian assets from short-and medium-range ballistic missile attacks. THAAD will include missiles, launcher, X-band radar, and a command and control battle management system. We assessed the Block 2008 initial capability expected to be available in 2009.

Source: THAAD Project Office/THAAD Graphics Section (Dynetics, Incorporated).



Program Essentials

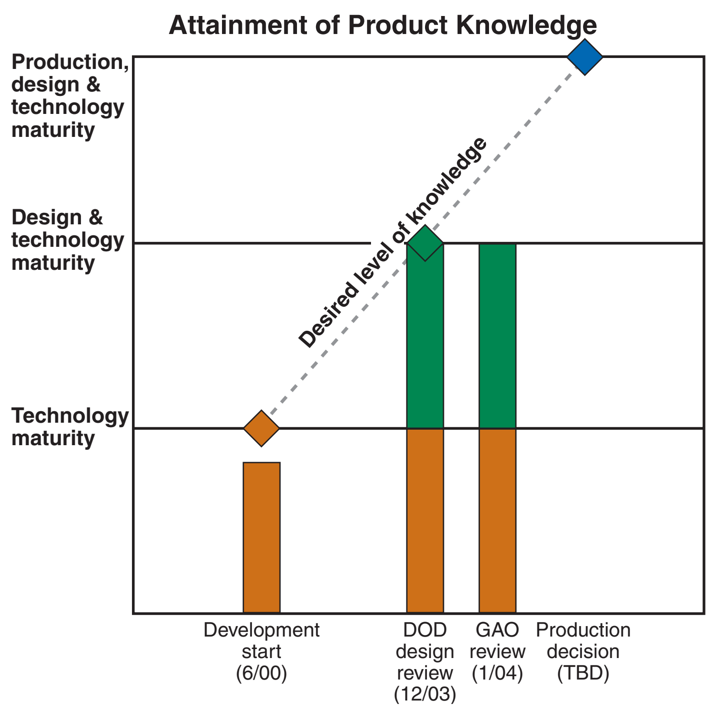
Prime contractor: Lockheed Martin
Program office: Huntsville, Ala.
Funding to complete through 2009:
R&D: $3,853.1 million
Procurement: $0.0 million
Total funding: $3,853.1 million
Procurement quantity: 0

Program Performance (fiscal year 2004 dollars in millions)

	As of NA	Latest 09/2003	Percent change
Research and development cost	NA	$10,769.8	0.0
Procurement cost	NA	$0.0	0.0
Total program cost	NA	$10,769.8	0.0
Program unit cost	**NA**	**$0.000**	**0.0**
Total quantities	NA	NA	NA
Acquisition cycle time (months)	TBD	TBD	TBD

Latest cost includes all costs from the program's inception through fiscal year 2009. Procurement funding and quantities have yet to be determined. NA = not applicable

THAAD's technologies are mature, and the design is stable. The capability of the design will be demonstrated in flight tests that are scheduled to begin in 2004. THAAD's initial deployment could occur sooner than planned if early flight tests are successful. The current THAAD acquisition strategy, as demonstrated by its extensive test program, shows a strong emphasis on attaining knowledge and using that knowledge to make acquisition decisions.



THAAD Program

Technology Maturity

The THAAD program office assessed all of its 50 critical technologies as mature. These technologies are included in four major components: command and control battle management and communications (C2BMC); interceptor; launcher; and radar. A new component, a primary power unit, will be added in the next few years, but this unit will most likely be purchased as a commercial off-the-shelf item.

Despite early test failures, the THAAD development program of the 1990s made progress in maturing critical technologies. Early flight-test failures were caused primarily by the program's compressed schedule and missile quality control problems. After these failures, program officials placed more emphasis on risk reduction efforts, which included using technology readiness levels to assess the maturity of critical technologies.

Design Maturity

The basic design of THAAD is essentially complete because the program has released approximately 100 percent of its engineering drawings. The program office successfully conducted the design review in December 2003.

THAAD's design is expected to change little between the design review and initial capability in 2009, when MDA plans to incorporate the element into the Ballistic Missile Defense System. However, if problems are identified during flight-testing, scheduled from 2004 to 2008, design changes could occur.

Other Program Issues

THAAD program officials stated their principal objective for the current block is the demonstration of a missile defense capability through flight-testing, enabling an initial defensive capability in 2009. However, achieving this capability will require approval to fabricate equipment for fielding and approval to redirect funds for this purpose. MDA is examining opportunities to deploy an earlier THAAD capability. For example, if early flight-testing is successful, MDA may consider reallocating funds to deliver a THAAD capability in 2006 or 2007. MDA officials are also examining whether THAAD's radar can serve as a forward-deployed radar for the Ballistic Missile Defense System. Further development, customization, and testing of the radar have begun in an effort to provide this capability in the next 2 years.

According to the program manager, the contractor has completed approximately 50 percent of the work under the existing THAAD contract and is performing work slightly ahead of schedule and under cost. Our analysis of contractor data confirms this assessment. The contract is being modified to align the program with MDA's block approach.

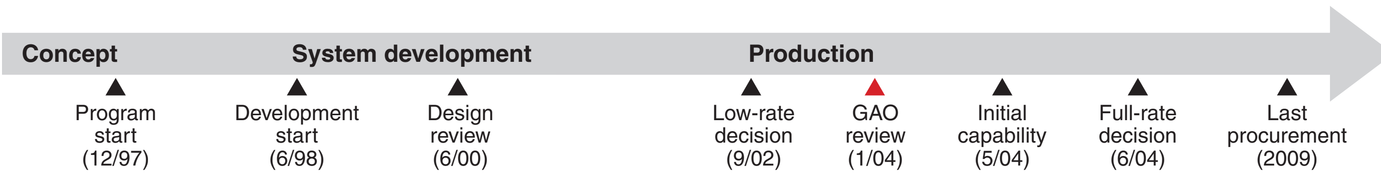
Program Office Comments

In commenting on a draft of this assessment, MDA generally agreed with the information provided in this report. Program officials also provided technical comments, which were incorporated where appropriate.

Tactical Tomahawk Missile

The Navy's Tactical Tomahawk (Block IV) is a major upgrade to the Tomahawk Land Attack Missile (Block III). The Tactical Tomahawk missile will provide ships and submarines with enhanced capability to attack targets on land. New features include improved antijamming global positioning system, in-flight retargeting, and the ability to transmit battle damage imagery. The system includes the missile, the weapon control system, and the mission planning system. We assessed only the missile.

Source: © November 2002 Tomahawk Program Office.



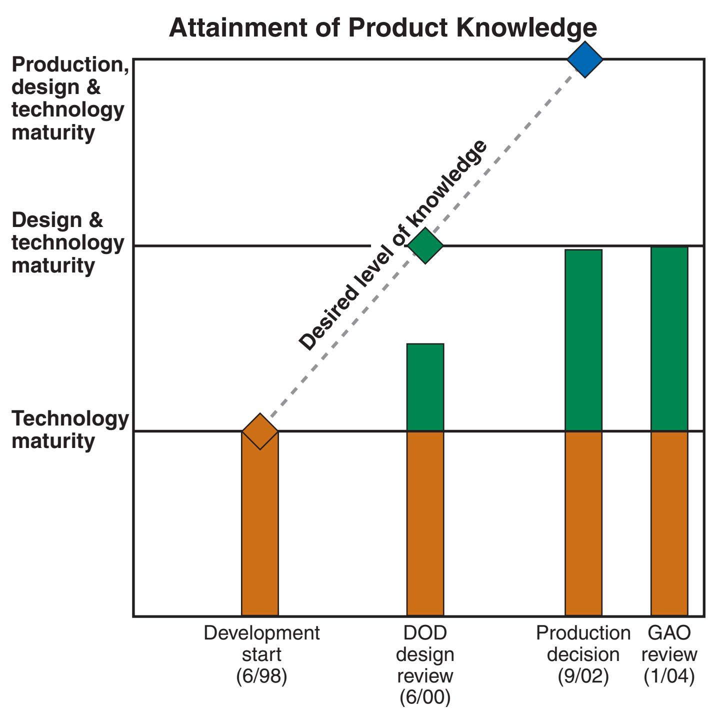
Program Essentials

Prime contractor: Raytheon Missile Systems
Program office: Patuxent River, Md.
Funding needed to complete:
- R&D: $19.6 million
- Procurement: $1,920.3 million
- Total funding: $1,939.9 million
- Procurement quantity: 2,194

Program Performance (fiscal year 2004 dollars in millions)

	As of 09/1997	Latest 12/2002	Percent change
Research and development cost	$559.8	$602.1	7.6
Procurement cost	$1,234.4	$2,236.4	81.2
Total program cost	$1,794.2	$2,838.4	58.2
Program unit cost	**$1.314**	**$1.185**	**-9.9**
Total quantities	1,365	2,396	75.5
Acquisition cycle time (months)	58	71	22.4

The Tactical Tomahawk missile entered low-rate production without ensuring that production processes were in control. Although program officials have identified critical processes and have procedures to capture statistical process control data, only preliminary data, gathered from the assembly of low-rate missiles, will be available by the full-rate decision in June 2004. Trend analysis is not expected until after the first complete low-rate delivery, scheduled for November 2004. Not until this time does the program expect to have tested sufficient missile quantities and have obtained adequate knowledge to determine whether the chosen process control metrics are valid and viable. The technology and design have reached full maturity.



Tomahawk Program

Technology Maturity

We did not assess the technology readiness levels of the key technologies for the Tactical Tomahawk missile because at the time of our review, critical technologies were already mature. According to the program office, the critical technologies for the key subsystems—antijamming global positioning system, digital scene matching area correlator, and cruise engine—were modified derivatives from other programs or upgrades to existing Tomahawk subsystems.

Design Maturity

The design of the Tactical Tomahawk missile is complete. At the time of the design review in June 2000, approximately 47 percent of the drawings had been released to manufacturing. By the end of technical evaluation in October 2003, 100 percent of the drawings had been released. Technical evaluation was successfully completed and the program entered operational evaluation in December 2003. Operational evaluation is scheduled to be completed in March 2004.

Production Maturity

Raytheon concluded that processes and controls are in place to successfully enter full-rate production. Officials have begun collecting statistical control data from the assembly of components for the first low-rate production cycle. Initial data in support of verifying critical process compliance is expected in March 2004. Program officials plan to establish preliminary boundaries for upper and lower control limits by the full-rate production decision in June 2004, but metrics are not expected to be fully stable until completion of the low-rate deliveries in November 2004. Full-rate production is planned as a multiyear procurement, from fiscal 2004 through fiscal year 2009.

Other Program Issues

Additional funding is expected from the Iraq Freedom Fund to accelerate replenishment of missiles expended in Operation Iraqi Freedom. The funding is expected to support a third low-rate production lot or an increase in full-rate quantities by an estimated 183 missiles. At the time of our review, negotiations had not been completed nor had the Navy acquisition strategy been approved.

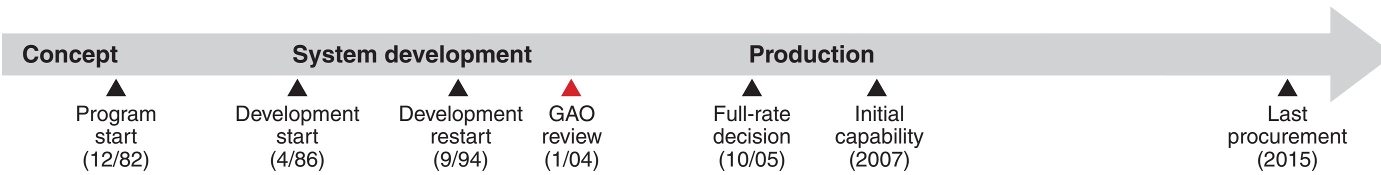
Program Office Comments

In commenting on a draft of this assessment, the program office noted that the Tactical Tomahawk missile successfully completed the technical evaluation test phase with an unprecedented eight for eight flight-test record. Program officials maintain that the design is sufficiently mature to enter full-rate production based on the completion of design reviews, technical evaluation, and the manufacture of 15 flight-test/qualification missiles prior to low-rate deliveries. The missile utilizes proven technologies from the Block 3 Tomahawk program and other currently fielded military programs. Key technologies utilized have been successfully demonstrated during development verification testing. Low-rate production has validated critical manufacturing processes and assured that critical design parameters are maintained. The program is currently meeting all fleet performance requirements and remains within acquisition program baseline cost, schedule, and performance thresholds.

V-22 Joint Services Advanced Vertical Lift Aircraft (V-22)

The V-22 Osprey is a tilt rotor, vertical takeoff and landing aircraft being developed by the Navy for joint service application. It is designed to meet the amphibious and vertical assault needs of the Marine Corps, the strike rescue needs of the Navy, and the special operations needs of the Air Force and 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, which has been undergoing changes to make it safe and operational.

Source: U.S. Navy.



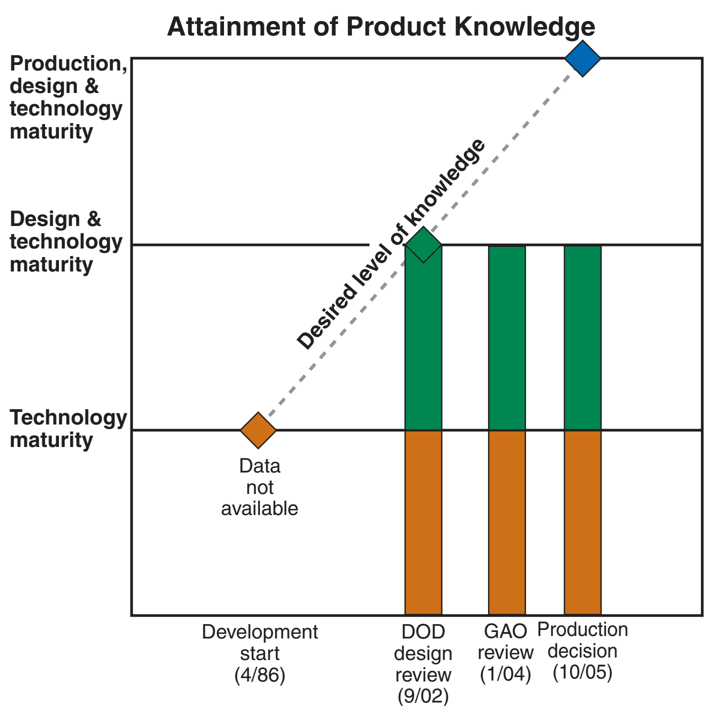
Program Essentials

Prime contractor: Bell-Boeing JPO
Program office: Patuxent River, Md.
Funding needed to complete:
R&D: $1,106.8 million
Procurement: $28,533.9 million
Total funding: $29,671.5 million
Procurement quantity: 397

Program Performance (fiscal year 2004 dollars in millions)

	As of 04/1986	Latest 12/2002	Percent change
Research and development cost	$3,601.1	$10,563.7	193.3
Procurement cost	$30,199.1	$35,411.1	17.3
Total program cost	$34,000.9	$46,025.9	35.4
Program unit cost	**$37.241**	**$100.493**	**169.8**
Total quantities	913	458	-49.8
Acquisition cycle time (months)	117	297	153.8

MV-22 Block A technologies are considered mature and the design is considered stable. Significant modification and redesign have taken place to address aircraft deficiencies that surfaced after fatal mishaps in 2000. The program's production effort has had parts shortages and quality issues with excessive scrap and rework. Corrections are in place and are being monitored to verify a positive and permanent fix. The program is using a new spiral development approach. Operational assessment of Block A is scheduled for January 2005 to April 2005 to support a recommendation regarding fleet introduction. However, the Marine Corps considers Block B the preferred configuration for operational deployment. Block B will have capability, reliability, and maintainability improvements. Operational assessment of the Block B configuration will not be completed until 2006.



V-22 Program

Technology Maturity

Although we did not specifically assess the MV-22's technology maturity, the program office states that based on DOD criteria, that the Block A technologies are considered mature.

Design Maturity

Design of Block A is essentially stable. Additional development tests directed after two fatal mishaps in 2000 resulted in redesigning the hydraulic and electrical lines. This increased the total number of drawings by 31 percent. Currently, 100 percent of drawings have been completed and released to manufacturing.

Production Maturity

The program office was not able to provide statistical process control data for measuring critical manufacturing processes. Contractors have recently begun to measure production maturity using Six Sigma, process certification, and process surveillance programs. Parts shortages and excessive scrap and rework, which have caused inefficiencies in assembly operations and cost growth, have been a production issue. However, corrective actions have been taken and a positive trend has emerged.

Other Program Issues

The V-22's $74 million unit cost is 28 percent greater than the $58 million unit cost the contractors believe is needed to generate V-22 sales. About a third of more than 100 identified cost reduction initiatives will be implemented using $58 million budgeted through fiscal year 2003. An August 8, 2003, program acquisition decision memorandum decreased program risk by limiting production. The savings from this adjustment will be used for interoperability improvements and further cost reduction initiatives to reduce production costs.

Concerns have been raised about the V-22's ability to operate safely while performing evasive maneuvers, especially in high workload and stressful situations. Also, while not a requirement, the aircraft cannot safely perform auto rotation while in helicopter mode. Operational effectiveness and suitability of Block A is scheduled to begin in January 2005. A number of key performance parameters—which are capabilities that if not met can be cause for program reevaluation, reassessment, or termination—were removed from the operational requirements document in October 2001 and redesignated so that they are no longer absolute requirements.

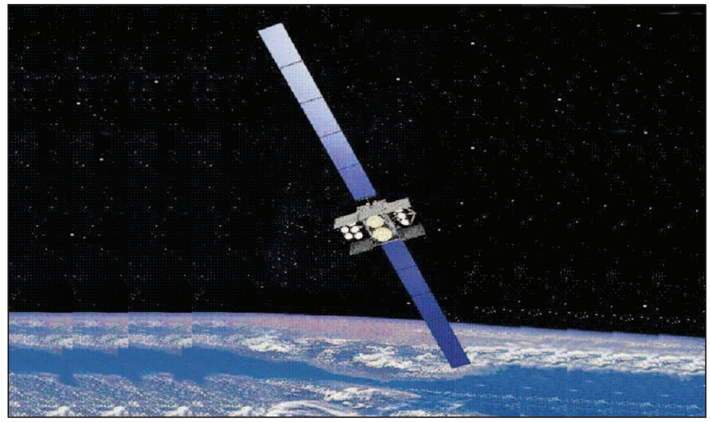
The Marine Corps states that the Block B aircraft is the preferred configuration for operational deployment. Block B development tests are scheduled for August 2003 to December 2005. Operational assessment of Block B is scheduled to begin in January 2006. Current plans are to shift MV-22 initial operational capability from September 2004 to fiscal year 2007.

Program Office Comments

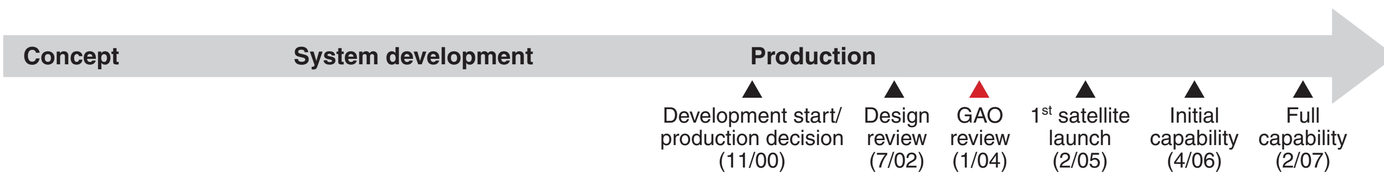
In commenting on a draft of this assessment, the program office stated that the program successfully implemented significant design changes that resulted from two catastrophic mishaps, as well as rebaselined the program. These changes have been implemented into delivered V-22s. An extremely comprehensive, event driven flight test program, reinitiated in May of 2002, accomplished 1,000 flight test hours on 9 test aircraft without mishap. A May 23, 2003, program acquisition decision memorandum stated that the program is proceeding well and that the V-22 has demonstrated safe and reliable operations in the flight envelope, combat maneuverability superior to helicopters, effective formation flying, acceptable handling qualities in low-speed flight with crosswinds, and other areas. The V-22 is meeting requirements for all its key performance parameters and reliability and maintainability metrics.

Wideband Gapfiller Satellites (WGS)

WGS is a joint Air Force and Army program intended to provide communications to the 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.



Source: WGS Program Office.



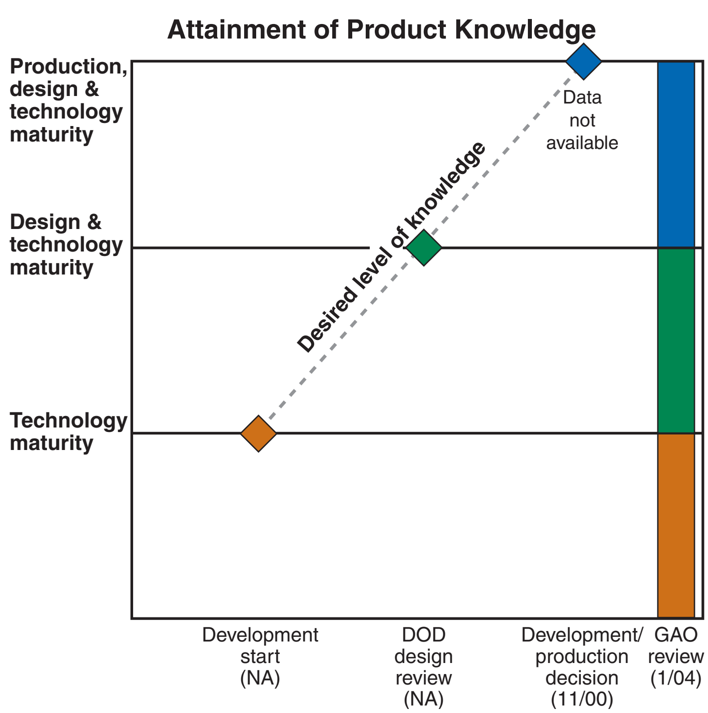
Program Essentials

Prime contractor: Boeing Satellite Systems
Program office: Los Angeles Air Force Base, Calif.
Funding needed to complete:
- R&D: $61.7 million
- Procurement: $664.6 million
- Total funding: $726.3 million
- Procurement quantity: 2

Program Performance (fiscal year 2004 dollars in millions)

	As of 12/2000	Latest 06/2003	Percent change
Research and development cost	$181.3	$230.8	27.3
Procurement cost	$829.8	$1,257.9	51.6
Total program cost	$1,011.1	$1,488.8	47.2
Program unit cost	**$337.046**	**$297.752**	**-11.7**
Total quantities	3	5	66.7
Acquisition cycle time (months)	50	77	54.0

The WGS program technology, design, and production are mature. However, integration issues and manufacturing problems have contributed to a delay in the launch of the first WGS satellite by over a year. The integration issues have since been rectified, but the manufacturing problems remain unresolved. A decision to delay the procurement of the fourth and fifth satellites is expected to increase program costs.



WGS Program

Technology Maturity

WGS' two key technologies were mature when the program entered production in November 2000. According to program officials, one of these technologies has been demonstrated successfully in the commercial sector.

Design Maturity

The WGS design is essentially complete, as the program office has released over 97 percent of the expected drawings to manufacturing. However, the contractor has experienced problems in integrating the phased array antenna into the satellite. The contractor assumed the antenna would be easily integrated because of similarity with portions of another commercial program. However, subsequent efforts invalidated this assumption and WGS experienced unanticipated design changes. Though the problems with integrating the antenna have since been resolved, they have contributed to a delay in the launch of the first satellite by over a year.

Production Maturity

According to program officials, the contractor has two key manufacturing processes, the automated wire-bonding and epoxy attach, both of which are under control. However, the automated wire-bonding process was not in control at the start of production due to the quality of the materiel supplied by the subcontractor. While this quality issue has been rectified, other manufacturing problems continue to delay the launch of the first satellite.

The manufacturing processes employed for the phased array antenna and the digital channelizer are relatively new. The contractor was relying on experiences gained in manufacturing these technologies in the commercial sector, but anticipated commercial orders for these technologies did not materialize and the manufacturing processes did not mature as expected. As a result, the contractor has experienced manufacturing problems with both technologies. The problems with manufacturing the digital channelizer have been resolved, but the contractor is still having difficulty manufacturing components for the phased array antenna at the rate required to meet the program schedule, further delaying the program.

Other Program Issues

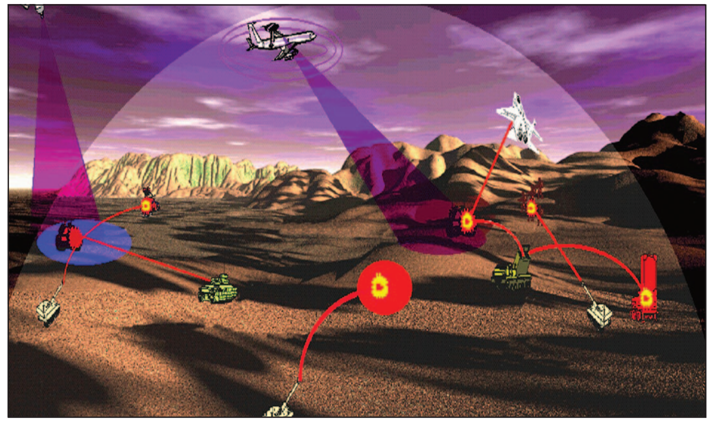
DOD directed that launches for satellites four and five be delayed to fiscal years 2009 and 2010, respectively. However, these dates are outside the allowable dates of the WGS contract option clauses and will likely cause a production gap. A decision to delay the procurement of the fourth and fifth satellites will increase program costs; however, the actual program increase will not be known until negotiations with the contractor are completed.

Program Office Comments

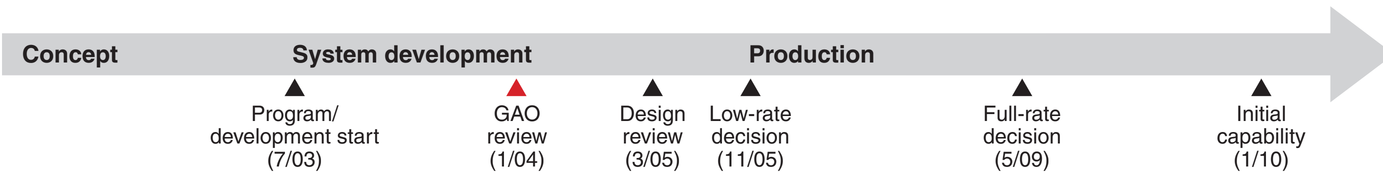
In commenting on a draft of this assessment, the program office stated that manufacturing problems with components on the phased array antenna continue to cause schedule delays. While the WGS Program Office and the contractor are trying to resolve the problems, the contractor has requested a delay in the launch of the first WGS satellite to December 2005. The 2-year gap in production caused by delaying the procurement of satellites four and five will result in higher costs for those satellites. The higher costs are the result of parts obsolescence, loss of manufacturing expertise, and greater costs to produce the first three satellites than the government or contractor originally predicted. The program office is assessing the expected cost increase to identify funding needs and will address it in the fiscal year 2006 President's Budget.

Warfighter Information Network-Tactical (WIN-T)

WIN-T is the Army's high-speed and high-capacity backbone communications network. It will provide reliable, secure, and seamless video, data, imagery, and voice services, allowing users to communicate simultaneously at various levels of security. The network will have the ability to be initialized and modified based upon unit task organization. WIN-T is being fielded in blocks, and we assessed the first block.



Source: PM WIN-T.



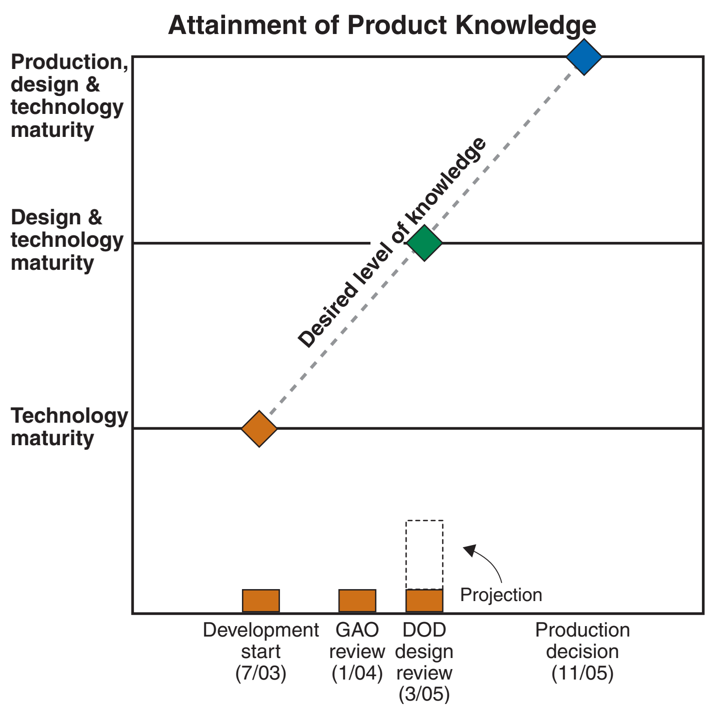
Program Essentials

Prime contractor: Lockheed Martin, General Dynamics
Program office: Fort Monmouth, N.J.
Funding needed to complete:
- R&D: $661.1 million
- Procurement: $9,290.7 million
- Total funding: $9,951.8 million
- Procurement quantity: 1

Program Performance (fiscal year 2004 dollars in millions)

	As of 07/2003	Latest 09/2003	Percent change
Research and development cost	$722.4	$722.4	0.0
Procurement cost	$9,290.7	$9,290.7	0.0
Total program cost	$10,013.1	$10,013.1	0.0
Program unit cost	**$10,013.094**	**$10,013.094**	**0.0**
Total quantities	1	1	0.0
Acquisition cycle time (months)	77	77	0.0

The WIN-T program entered system development with 3 of its 12 critical technologies close to reaching full maturity. None of these technologies are expected to be fully mature until after design review in March 2005. Eight have mature backup technologies available. However, use of these technologies would degrade system overall reliability, security, and performance. Because of the significant interdependencies among critical technologies, and the fact that some describe network functionality, it may not be possible to fully mature these technologies until after production begins. Design and production maturity could not be assessed because the program office does not track the number of releasable drawings or the number of production processes in control as metrics. WIN-T is primarily an information technology system integration effort rather than a manufacturing effort.



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 technologies to reach full maturity until the network is built and can be demonstrated in an operational environment, they do expect the technologies to have been demonstrated in a simulated operational environment by the time design review is held in March 2005. A technology readiness assessment determined that WIN-T would enter system development prior to full definition of the first block's design and specific technology-based components, systems or subsystems. WIN-T will include technologies such as switching/routing and subscriber access nodes; handheld terminal; information assurance; information dissemination; transmission systems; and network management, some of which are expected to undergo continuous maturation up until the design review.

Design Maturity

Design maturity could not be assessed because the program office does not plan to track the number of releasable drawings as a design metric. According to the program office, 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 WIN-T components, particularly commercial components. The WIN-T design will evolve using performance-based specifications and open systems design and is to conform to DOD's Joint Technical Architecture.

Production Maturity

Production maturity for the entire system could not be assessed because the program does not plan to track manufacturing metrics for all WIN-T components. According to the program office, WIN-T is not a manufacturing effort, but primarily an information technology system integration effort. Consequently, the government does not collect information on the manufacturing statistical process control for many WIN-T components, including commercial components. To ensure industrial capabilities are reasonably available, a production readiness review will be conducted prior to the end of system development.

Other Program Issues

Additional areas that will require close attention by the program office include the interdependence of WIN-T with FCS and JTRS programs; the interdependence between WIN-T, FCS, and Global Information Grid requirements; the scalability of WIN-T; the system-of-systems challenge of linking all nodes and networks; the coordination of unmanned relay programs with FCS; tracking external factors that will affect WIN-T such as the DOD Net-Centric Data Strategy, U.S. Strategic Command's oversight of Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance, Network Operations and others; and coordination of Technology Transition Agreements. WIN-T deployment will be essential for FCS deployment. As each system evolves, integration demonstrations will need to be performed to ensure WIN-T and FCS interoperability.

Program Office Comments

In commenting on a draft of this assessment, the program office stated that it is managing risks related to technology, design, and production maturity by requiring contractors to develop critical technology maturation plans and to demonstrate technology maturity prior to or during the developmental testing/operational testing event scheduled soon after the March 2005 design review. The program office is also monitoring the maturity of form, fit, and function of prototype equipment to be demonstrated in the testing event relative to the production design.

Agency Comments

DOD did not provide general comments on a draft of this report, but did provide technical comments on individual assessments. These comments, along with program office comments, are included with each individual assessment as appropriate. (See app. I for a copy of DOD's response.)

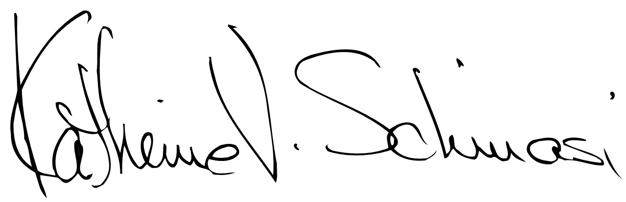
Scope of Our Review

For the 51 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 risk—but 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 51 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.

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 Minority Member
Committee on Armed Services
House of Representatives

The Honorable Jerry Lewis
Chairman
The Honorable John P. Murtha
Ranking Minority 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 17 2004

Mr. Paul Francis
Director, Acquisition and Sourcing Management
U.S. General Accounting 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 17, 2004 (GAO Code 120272/GAO-04-248). 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,

Deidre A. Lee
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 or verify 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 these discrepancies with program officials and adjusted the data accordingly.

System Profile Assessment

In the past 3 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 51 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.

The information presented on the funding needed to complete from fiscal 2004 through completion, unless otherwise noted, draws on information from Selected Acquisition Reports or on data from the program office. In some instances this data was not available, and we annotate this by the term “to be determined” (TBD). The program cost comparisons are the latest estimates provided by the individual programs. The quantities listed refer to total quantities, including both procurement and development quantities.

To assess the cost, schedule, and quantity changes of each program, we reviewed DOD's Selected Acquisition Reports or obtained data directly from the program offices. In general, we compared the latest available Selected Acquisition Report information with a baseline for each program. For systems that have started system development—those that are beyond milestone II or B—we compared the latest available Selected Acquisition Report 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 Selected Acquisition Reports, we attempted to obtain comparable baseline and current data from the individual program offices.

All cost information is presented in base year 2004 dollars, unless otherwise noted, 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 was not applicable and we annotate this by using the term "NA."

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 was not available or classified, and we annotate this by using the term TBD.

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 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 2-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 appendix 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 considered mature and those that have reached technology readiness level 6, a prototype demonstrated in a relevant environment, 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 maturity, 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. 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. 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.[1] 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 was 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.

[1] Process Capability Index provides assurance that production processes are under 100 percent statistical control. A high index value equates to fewer defects per part based on statistical process control data. The general rule of thumb used by the manufacturing industry states that if the index value for a process is less than 1.33, then the process is not capable of producing a part with acceptable consistency.

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.

(Continued From Previous Page)

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

GAO Contact

Paul Francis (202) 512-4841

Acknowledgments

David B. Best, Leslie M. Hickey, and James L. Morrison made key contributions to this report. Other key contributors included Robert L. Ackley, Dora C. Baltzell, Cristina T. Chaplain, Lily J. Chin, Thomas J. Denomme, James A. Elgas, Arthur Gallegos, William R. Graveline, David J. Hand, Barbara H. Haynes, Sigrid L. McGinty, John E. Oppenheim, Maria-Alaina I. Rambus, Rae Ann H. Sapp, Ronald E. Schwenn, Wendy P. Smythe, Michael J. Sullivan, Robert S. Swierczek, Adam Vodraska, and Karen S. Zuckerstein. The following staff were responsible for individual programs:

System	Primary staff
Airborne Laser (ABL)	Marcus C. Ferguson/ Tana M. Davis
Aegis Ballistic Missile Defense (Aegis BMD)	Tana M. Davis/ Richard A. Cederholm
Advanced Extremely High Frequency Satellite (AEHF)	Bradley L. Terry/ Brian W. Eddington
Active Electronically Scanned Array Radar (AESA)	Jerry W. Clark/ Gaines R. Hensley/ Bonita P. Oden
Advanced Precision Kill Weapon System (APKWS)	John S. Warren Jr./ Wendy P. Smythe
Advanced SEAL Delivery System (ASDS)	Mary K. Quinlan
Advanced Threat Infrared Countermeasure/Common Missile Warning System (ATIRCM/CMWS)	Jonathan E. Watkins/ Danny G. Owens
Advanced Wideband Satellite/Transformational Satellite (AWS/TSat)	Matthew R. Mongin/ David G. Hubbell/ Travis J. Masters
B-2 Radar Modernization Program (B-2)	Don M. Springman/ Arthur L. Cobb
C-130 Avionics Modernization Program (C-130 AMP)	Katrina D. Taylor/ Christopher A. Deperro
C-5 Avionics Modernization Program (C-5 AMP)	Roger S. Corrado/ Sameena S. Nooruddin
C-5 Reliability Enhancement and Reengining Program (C-5 RERP)	Sameena S. Nooruddin/ Roger S. Corrado
Cooperative Engagement Capability (CEC)	Johana R. Ayers/ Leslie M. Hickey
CH-47F Improved Cargo Helicopter (CH-47)	Leon S. Gill/ Wendy P. Smythe

(Continued From Previous Page)

System	Primary staff
Comanche Reconnaissance Attack Helicopter (RAH-66)	Wendy P. Smythe/ Leon S. Gill
Future Aircraft Carrier CVN-21	J. Kristopher Keener/ Tedra Cannella
DD(X) Destroyer	J. Kristopher Keener/ Chris Durbin
E-10A Multi-Sensor Command and Control Aircraft (E-10A)	Joseph E. Dewechter/ Jerry W. Clark/ Bonita P. Oden
E-2 Advanced Hawkeye (E-2 AHE)	Bruce H. Thomas/ Gary L. Middleton
EA-18G Growler (EA-18G)	Christopher R. Miller/ Brian T. Mullins/ Lillian I. Slodkowski
Evolved Expendable Launch Vehicle (EELV)	Maria A. Durant
Expeditionary Fighting Vehicle (EFV)	Chad R. Holmes/ Dayna L. Foster
Extended Range Guided Munition (ERGM)	Ronald E. Schwenn/ Shelby S. Oakley/ Carmen T. Donohue
Excalibur Precision Guided Extended Range Artillery Projectile	Lawrence D. Gaston Jr./ John P. Swain
F/A-22 Raptor	Marvin E. Bonner/ Edward R. Browning
Future Combat Systems (FCS)	John P. Swain/ Lawrence D. Gaston Jr.
Global Hawk Unmanned Aerial Vehicle	Bruce D. Fairbairn/ Matthew B. Lea
Ground-Based Midcourse Defense (GMD)	Diana L. Dinkelacker/ Randolph S. Zounes
Joint Air-to-Surface Standoff Missile (JASSM)	Beverly A. Breen/ LaTonya D. Miller
Joint Common Missile	Danny G. Owens/ Jonathan E. Watkins
Joint Helmet Mounted Cueing System (JHMCS)	Dayna L. Foster/ Michael W. Aiken
Joint Strike Fighter (JSF)	Brian T. Mullins/ Brendan S. Culley
Joint Standoff Weapon (JSOW)	Carol T. Mebane/ Ivy G. Hubler
Joint Tactical Radio System (JTRS)	Joel C. Christenson/ James P. Tallon
Littoral Combat Ship (LCS)	J. Kristopher Keener/ Tedra Cannella
Long-term Mine Reconnaissance System (LMRS)	Ian A. Ferguson/ Ricardo A. Marquez/ Gaines R. Hensley
Minuteman III Guided Replacement Program (MM III GRP)	Brian W. Eddington/ Arturo Holguin Jr.
Minuteman III Propulsion Replacement Program (MM III PRP)	Arturo Holguin Jr./ Brian W. Eddington
Mobile User Objective System (MUOS)	Travis J. Masters/ Matthew R. Mongin
National Polar-Orbiting Operational Environmental Satellite System (NPOESS)	Yvonne J. Vigil/ Bruce H. Thomas
Guided Missile System Air Defense (Patriot) PAC-3 Program	James A. Elgas/ William S. Lipscomb
MQ-9 Predator B	Steven M. Hunter/ Cheryl K. Andrew

(Continued From Previous Page)

System	Primary staff
Space Based Infrared System High (SBIRS High)	Nancy Rothlisberger/ Maricela Cherveny
Small Diameter Bomb (SDB)	LaTonya D. Miller/ Beverly A. Breen
RQ-7A Shadow 200 Unmanned Aerial Vehicle System (Shadow 200)	Matt B. Lea
Space Tracking & Surveillance System (STSS)	Sigrid L. McGinty/ Richard Y. Horiuchi
Theater High Altitude Area Defense (THAAD)	Carrie R. Wilson/ Tana M. Davis
Tactical Tomahawk Missile	Ivy G. Hubler/ Carol T. Mebane
V-22 Joint Services Advanced Vertical Lift Aircraft (V-22)	Jerry W. Clark/ Joseph E. Dewechter/ Bonita P. Oden
Wideband Gapfiller Satellites (WGS)	Tony A. Beckham/ Arthur Gallegos
Warfighter Information Network-Tactical (WIN-T)	James P. Tallon/ Joel C. Christenson

Source: GAO.

Related GAO Products

Best Practices: Setting Requirements Differently Could Reduce Weapon Systems' Total Ownership Costs. GAO-03-57. Washington, D.C.: February 11, 2003.

Defense Acquisitions: DOD's Revised Policy Emphasizes Best Practices, but More Controls Are Needed. GAO-04-53. Washington, D.C.: November 10, 2003.

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

Defense Acquisitions: DOD Faces Challenges in Implementing Best Practices. GAO-02-469T. Washington, D.C.: February 27, 2002.

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

Best Practices: A More Constructive Test Approach Is Key to Better Weapon System Outcomes. GAO/NSIAD-00-199. Washington, D.C.: July 31, 2000.

Defense Acquisition: Employing Best Practices Can Shape Better Weapon System Decisions. GAO/T-NSIAD-00-137. Washington, D.C.: April 26, 2000.

Best Practices: DOD Training Can Do More to Help Weapon System Program Implement Best Practices. GAO/NSIAD-99-206. Washington, D.C.: August 16, 1999.

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

Defense Acquisitions: Best Commercial Practices Can Improve Program Outcomes. GAO/T-NSIAD-99-116. Washington, D.C.: March 17, 1999.

Defense Acquisition: Improved Program Outcomes Are Possible. GAO/T-NSIAD-98-123. Washington, D.C.: March 18, 1998.

Best Practices: DOD Can Help Suppliers Contribute More to Weapon System Programs. GAO/NSIAD-98-87. Washington, D.C.: March 17, 1998.

Best Practices: Successful Application to Weapon Acquisition Requires Changes in DOD's Environment. GAO/NSIAD-98-56. Washington, D.C.: February 24, 1998.

Major Acquisitions: Significant Changes Underway in DOD's Earned Value Management Process. GAO/NSIAD-97-108. Washington, D.C.: May 5, 1997.

Best Practices: Commercial Quality Assurance Practices Offer Improvements for DOD. GAO/NSIAD-96-162. Washington, D.C.: August 26, 1996.

United States
General Accounting Office
Washington, D.C. 20548-0001

Official Business
Penalty for Private Use $300

Address Service Requested

Presorted Standard
Postage & Fees Paid
GAO
Permit No. GI00

[redacted]