

**GAO**

Report to the Chairman, Subcommittee  
on National Security and Foreign  
Affairs, Committee on Oversight and  
Government Reform, House of  
Representatives

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September 2009

# DEFENSE ACQUISITIONS

## Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options



**GAO**

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Highlights of [GAO-09-665](#), a report to the Chairman, Subcommittee on National Security and Foreign Affairs, Committee on Oversight and Government Reform, U.S. House of Representatives

## Why GAO Did This Study

Department of Defense (DOD) weapon programs often experience significant cost and schedule problems because they are allowed to start with too many technical unknowns and not enough knowledge about the development and production risks they entail. GAO was asked to review the department's Analysis of Alternatives (AOA) process—a key first step in the acquisition process intended to assess the operational effectiveness, costs, and risks of alternative weapon system solutions for addressing a validated warfighting need. This report (1) examines whether AOAs have been effective in identifying the most promising options and providing a sound rationale for weapon program initiation, (2) determines what factors have affected the scope and quality of AOAs, and (3) assesses whether recent DOD policy changes will enhance the effectiveness of AOAs. To meet these objectives, GAO efforts included collecting information on AOAs from 32 major defense acquisition programs, reviewing guidance and other documents, and interviewing subject matter experts.

## What GAO Recommends

GAO is recommending that DOD establish criteria and guidance for how AOAs should be conducted and ensure AOAs are completed before requirements are set. DOD concurred, and stated that recently revised policies improve AOAs. We believe that the policy revisions do not go far enough to address our recommendations.

[View GAO-09-665 or key components.](#)  
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## DEFENSE ACQUISITIONS

### Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options

#### What GAO Found

Although an AOA is just one of several inputs required to initiate a weapon system program, a robust AOA can be a key element to ensure that new programs have a sound, executable business case. Many of the AOAs that GAO reviewed did not effectively consider a broad range of alternatives for addressing a warfighting need or assess technical and other risks associated with each alternative. For example, the AOA for the Future Combat System program, one of DOD's large and most complex development efforts, analyzed the operational performance and cost of its alternatives but failed to compare the technical feasibility and risks, assuming that the technologies would perform as forecasted. Without a sufficient comparison of alternatives and focus on technical and other risks, AOAs may identify solutions that are not feasible and decision makers may approve programs based on limited knowledge. While many factors can affect cost and schedule outcomes, we found that programs that had a limited assessment of alternatives tended to have poorer outcomes than those that had more robust AOAs.

The narrow scope and limited risk analyses in AOAs can be attributed in part to program sponsors choosing a solution too early in the process, the compressed timeframes that AOAs are conducted under, and the lack of guidance for conducting AOAs. While AOAs are supposed to provide a reliable and objective assessment of viable weapon solutions, we found that service sponsors sometimes identify a preferred solution or a narrow range of solutions early on, before an AOA is conducted. The timing of AOAs has also been problematic. Some AOAs are conducted under compressed timeframes in order to meet a planned milestone or weapon system fielding date and are conducted concurrently with other key activities required to become a program of record. This can short-change a comprehensive assessment of risks and preclude effective cost, schedule, and performance trade offs from taking place prior to beginning development. Furthermore, while DOD has an opportunity to influence the scope and quality of AOAs, it has not always provided guidance for conducting individual AOAs.

Recognizing the need for more discipline in weapon systems acquisition, DOD recently revised its overall acquisition and requirements policies. If implemented properly, the revised policies could provide a better foundation for planning and starting new programs with sound, knowledge-based business cases. Included in the revised acquisition policy are several mechanisms to improve the AOA process. For example, the policy revisions should help ensure that DOD direction is provided before AOAs are started and that they are conducted at an early point in the acquisition process where their results can inform decisions affecting program initiation. While these policy changes are promising, DOD must ensure that they are consistently implemented and reflected in decisions on individual programs. Furthermore, more specific criteria and guidance for how AOAs should be conducted may need to be developed to ensure they meet their intended objectives and provide an in-depth assessment of alternatives.

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United States Government Accountability Office  
Washington, DC 20548

September 24, 2009

The Honorable John F. Tierney  
Chairman  
Subcommittee on National Security and Foreign Affairs  
Committee on Oversight and Government Reform  
House of Representatives

Dear Mr. Chairman:

Cost, schedule, and performance problems in the Department of Defense's (DOD) weapon system programs are serious. Recently, we reported that the department's 2008 portfolio of 96 major defense acquisition programs experienced cost growth of \$296 billion, experienced an average delay in delivering initial capabilities of 22 months, and have delivered fewer quantities and capabilities to the warfighter than originally planned.<sup>1</sup> Over the past several years, our work has highlighted a number of underlying causes for why poor outcomes have occurred in weapon programs. One key cause is that DOD allows programs to begin without a sound match between requirements and the resources needed to achieve them. That is, programs enter the acquisition process with requirements that are not fully understood, cost and schedule estimates that are based on optimistic assumptions, and a lack of sufficient knowledge about technology, design, and manufacturing.

With the growing fiscal pressures now facing the nation, DOD needs to get the best value for every dollar it invests in weapon system programs. The department's management of its weapon system programs has been a matter of congressional concern for many years. In 2008, the Subcommittee requested that we study how DOD makes trade offs in requirements, costs, and technical risks before approving programs to start development. Specifically, the Subcommittee asked us to review the department's Analysis of Alternatives (AOA) process—a key first step in the acquisition process intended to assess the operational effectiveness, costs, and risks of alternative weapon system solutions for addressing a validated warfighting need. Determining what type of weapon system to pursue is critical because, according to a recent estimate, about three-

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<sup>1</sup> GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, [GAO-09-326SP](#) (Washington, D.C.: Mar. 30, 2009).

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quarters of a program's total life-cycle cost is influenced by decisions made before it is approved to start development.<sup>2</sup> This report assesses (1) whether AOAs have been effective in identifying the most promising options and providing a sound rationale for weapon program initiation, (2) the factors that affect the scope and quality of AOAs, and (3) whether recent DOD policy changes will enhance the effectiveness of AOAs.

To assess DOD's AOA process, we reviewed relevant DOD and military service policy and guidance, and interviewed officials from the Joint Staff, Office of Program Analysis & Evaluation, Air Force Office of Aerospace Studies, Army Training and Doctrine Command Analysis Center, and other subject matter experts. We also collected and analyzed information on AOAs from 32 major defense acquisition programs<sup>3</sup> that had started since fiscal year 2003.<sup>4</sup> We obtained information from program officials on how these AOAs were conducted and whether the AOAs contributed to changes in the program's weapon system concept. Furthermore, we reviewed AOA documents and DOD and service guidance for conducting these AOAs. In reviewing AOAs, we examined the scope of alternatives that were considered and the extent of risk assessments conducted for each alternative. This work was conducted from June 2008 to September 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings

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<sup>2</sup> National Research Council, *Pre-Milestone A and Early Phase Systems Engineering: A Retrospective Review and Benefits for Future Air Force Systems Acquisition* (Washington, D.C.: 2008).

<sup>3</sup> Major defense acquisition programs, referred to as acquisition category (ACAT) I programs, are defined as those that are expected to exceed \$365 million (in fiscal year 2000 constant dollars) in research, development, test, and evaluation (RDT&E) or \$2.19 billion (in fiscal year 2000 constant dollars) in procurement costs. For ACAT ID programs, the Under Secretary of Defense for Acquisition, Technology, and Logistics serves as the Milestone Decision Authority (MDA) and determines whether the program can proceed to the next phase of acquisition while, for ACAT IC programs, the MDA is the head of the DOD component or, if delegated, the service Component Acquisition Executive.

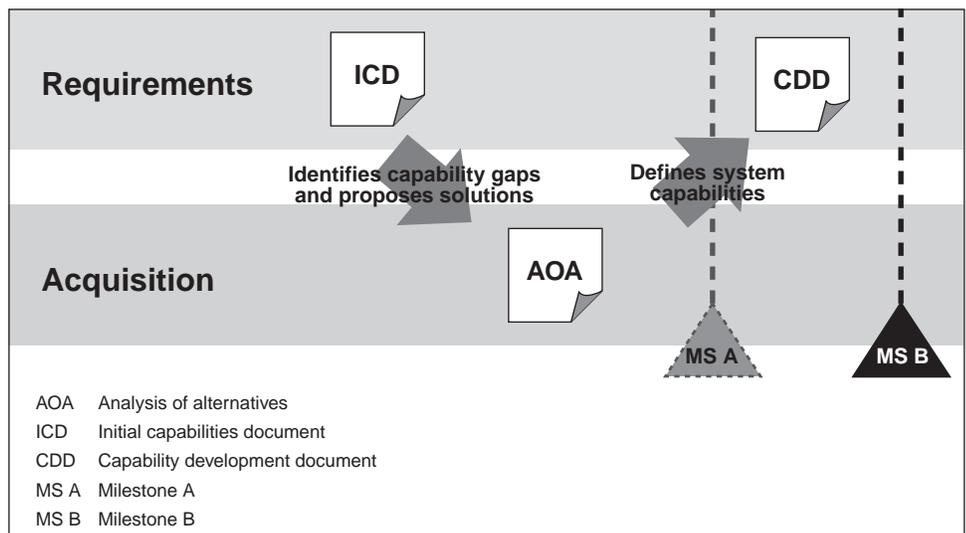
<sup>4</sup> We selected programs that started after 2003, to correspond with significant revisions that had been made to DOD's acquisition policy at that time.

and conclusions based on our audit objectives. Additional information about our scope and methodology is provided in appendix I; appendix III contains information about the programs and AOAs we reviewed.

## Background

Before service or joint sponsors can initiate major defense acquisition programs and begin system development at Milestone (MS) B, they are required by DOD’s acquisition policy to conduct an AOA.<sup>5</sup> The AOA is an analytical study that is intended to compare the operational effectiveness, cost, and risks of a number of alternative potential solutions to address valid needs and shortfalls in operational capability. The basis for conducting an AOA begins when a capability need is validated or approved through the department’s requirements determination process—the Joint Capabilities Integration and Development System (JCIDS) (See fig. 1).

**Figure 1: Where AOAs Fit within the Requirements and Acquisition Processes**



Source: GAO presentation of DOD policies.

<sup>5</sup> DOD’s acquisition policy covering the time frame of our analysis, including guidance for conducting AOAs, is contained in DOD Instruction 5000.2, May 2003 revision to the *Operation of the Defense Acquisition System*. If a program does not require development, it may enter at Milestone C. DOD Instruction 5000.2 was revised and reissued as DOD Instruction 5000.02 in December 2008.

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A sponsor, usually a military service, submits a capability proposal—called an Initial Capabilities Document (ICD)—through JCIDS, which identifies the existence of a capability gap, the operational risks associated with the gap, and a recommended solution or preferred set of solutions for filling the gap. When a capability proposal is validated, before a major defense acquisition program begins, an AOA is undertaken to compare potential solutions and determine the most promising and cost-effective weapon system to acquire. The AOA is a key input to defining the system capabilities of the major defense acquisition program, which are established in a capability development document (CDD).

Most AOAs are sponsored by a single military service, but some may be conducted jointly by more than one service, in which case, the Milestone Decision Authority (MDA) designates a lead service as the sponsor. AOAs are conducted by study teams, the composition of which depends on the service—most of the Army’s AOAs are conducted by the Army’s Training and Doctrine Command Analysis Center, most of the Air Force’s AOAs are conducted by the Air Force’s major commands, such as the Air Combat Command, and most of the Navy’s AOAs are contracted out to federally funded research and development centers and the Navy’s various study centers. Both the Office of the Secretary of Defense (OSD) and the services are responsible for issuing study guidance to scope the AOA, which provide a minimum set of alternatives to analyze and shape the analysis through a series of study questions. Conducting an AOA may take anywhere from a few months to several years and cost from a few hundred thousand to several million dollars depending on its scope and complexity. The final results and recommendations of the AOA are then presented to decision makers, who decide on which alternative to select for program initiation. According to the Air Force’s manual<sup>6</sup> on conducting AOAs, some of the key questions that decision makers need the AOA to answer include:

- What alternatives provide validated capabilities?
- Are the alternatives operationally suitable and effective?
- Can the alternatives be supported?
- What are the risks (technical, operational, programmatic) for each alternative?
- What are the life-cycle costs for each alternative?
- How do the alternatives compare to one another?

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<sup>6</sup> While DOD Instruction 5000.2 provides general policy for conducting AOAs, it does not specify how AOAs should be conducted. The Air Force has developed detailed guidance for conducting AOAs.

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The Office of the Secretary of Defense, Program Analysis and Evaluation (OSD PA&E), plays a central role in the AOA process because it is responsible for providing initial guidance to the AOA study team, reviewing the proposed AOA study plan, and assessing the completed AOA. In carrying out these functions, OSD PA&E provides a DOD enterprise-level perspective to AOAs and encourages service sponsors to consider all viable concepts to fill a capability need, even if they were not initially considered by the service sponsors, and to assess technical risks and costs of each alternative.

The AOA is one of several inputs required for a program's initiation at MS B,<sup>7</sup> and it is a key element in planning and establishing a sound business case for a weapon system program. We have frequently reported on the importance of using a solid, executable business case before committing resources to a new product development effort.<sup>8</sup> The business case in its simplest form is demonstrated evidence that (1) the warfighter's needs are valid and that they can best be met with the chosen concept, and (2) the chosen concept can be developed and produced within existing resources—that is, proven technologies, design knowledge, adequate funding, and adequate time to deliver the product when it is needed. The AOA addresses the first point of a business case by providing a foundation for developing and refining the operational requirements for a weapon system program. An AOA also addresses the second point of a business case by providing insight into the technical feasibility and costs of alternatives. By contributing to business cases, AOAs should provide programs with a sound basis for program initiation.

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<sup>7</sup> Other key elements required for Milestone B include the technology readiness assessment, independent cost estimate, acquisition strategy, and Capability Development Document (CDD).

<sup>8</sup> GAO, *Defense Acquisitions: Sound Business Case Needed to Implement Missile Defense Agency's Targets Program*, [GAO-08-1113](#) (Washington, D.C.: Sept. 26, 2008), *Defense Acquisitions: Improved Business Case Is Needed for Future Combat System's Successful Outcome*, [GAO-06-367](#) (Washington, D.C.: Mar. 14, 2006), and *Tactical Aircraft: Air Force Still Needs Business Case to Support F/A-22 Quantities and Increased Capabilities*, [GAO-05-304](#) (Washington, D.C.: Mar. 15, 2005).

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## Most Programs Have Not Conducted a Robust Assessment of Alternatives

Most of the programs we reviewed either did not conduct an AOA or conducted an AOA that focused on a narrow scope of alternatives and did not adequately assess and compare technical and other risks of each alternative. While many factors can affect program cost and schedule outcomes, we found that programs that conducted a limited assessment of alternatives before the start of system development tended to experience poorer outcomes than the programs that conducted more robust AOAs. According to several DOD and program officials, AOAs have often simply validated a concept selected by the sponsor and are not used as intended to make trade offs among performance, cost, and risks to achieve an optimal weapon system concept that satisfies the warfighter's needs within available resource constraints.

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## Most Programs Analyzed a Narrow Scope of Alternatives before They Started

Most of the programs we reviewed considered a narrow scope of alternatives to support program start. Ten of the 32 programs did not conduct AOAs and focused on an already selected weapon system solution. Of the 22 programs that had AOAs, 13 of them examined a limited number of alternatives within a single weapon system concept such as helicopters or specific classes of ships, while 9 considered a relatively broad range of alternatives, by assessing many alternatives within a single weapon concept or alternatives across multiple concepts, such as comparing ships to aircraft. We found that the programs that considered a broad range of alternatives tended to have better cost and schedule outcomes than the programs that looked at a narrow scope of alternatives (see table 1). For example, 1 of the 9 programs that examined a broad set of alternatives experienced high cost or schedule growth whereas 8 of the 13 programs that considered only a limited number of alternatives experienced high cost or schedule growth.

**Table 1: Comparison of the Scope of Alternatives Considered with Program Cost and Schedule Growth**

Scope of alternatives <sup>b</sup>	Number of programs with cost or schedule growth <sup>a</sup>		
	Low	Moderate	High
No AOA conducted	7	0	3
AOA included broad scope of alternatives	7	1	1
AOA included narrow scope of alternatives	4	1	8

Source: GAO.

<sup>a</sup> Cost growth: High = 25 percent or greater growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Moderate = 10 to 24 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Low = less than 10 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates.

Schedule growth: High = greater than 12 month delay for the initial operational capability date or acquisition cycle, Moderate = 7 to 12 month delay for the initial operational capability date or acquisition cycle, Low = less than 7 month delay for the initial operational capability date or acquisition cycle.

<sup>b</sup> Narrow scope of alternatives = 2-5 alternatives within one concept; broad scope of alternatives = 8-26 alternatives within one concept, or alternatives within multiple concepts.

## Programs That Did Not Conduct AOAs

For various reasons, 10 of the 32 weapon programs we reviewed did not have formal AOAs to support program start (see table 2). For 7 of these programs, it may have been appropriate not to conduct the AOA because the programs involved a planned modernization to an existing weapon system or there was support from other analyses to warrant the chosen concept. This was the case, for example, with the Navy’s Standard Missile 6 (SM-6) program. Because the missile was the next planned increment in a long history of missile development efforts and an AOA had been conducted for the previous standard missile increment, a separate AOA for SM-6 was considered repetitive and waived. The program started development in 2004 and has remained on track with its planned cost and schedule objectives. Similarly, an AOA was not conducted for the Air Force’s Global Positioning System IIIA program because there was a body of analysis available that served the purpose of an AOA and the proposed program was considered a follow-on increment to a multiprogram effort to modernize global positioning system capabilities. Since it started development in 2008, the program has remained on cost and schedule.

**Table 2: Programs That Did Not Conduct AOAs**

<b>Program</b>	<b>Reasons for not conducting an AOA</b>	<b>Cost or schedule growth (low, moderate, or high)<sup>a</sup></b>
B-2 RMP – B-2 Radar Modernization Program	The Radar Modernization Program (RMP) only changes the operating frequency of the radar with no functional upgrades. The B-2 system program office considers the analysis leading to the radar modernization to be an informal AOA.	Low
B-2 EHF INCREMENT I – B-2 Advanced Extremely High Frequency SatCom Capability	The program had previous analyses on processors and antennas that fulfilled the intent of an AOA. The milestone decision authority for the program waived the AOA requirement.	Low
F-22A Modernization Program	The F-22 program had completed a cost and operational effectiveness analysis in 1991. No analysis was conducted for the modernization component of the F-22 program.	High
Global Positioning Satellite III (GPS IIIA)	The Air Force had conducted multiple studies and analyses that together fulfilled the intent of an AOA.	Low
JTRS HMS – Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios	The Army conducted a study which represents the results of a mission needs analysis, an operational requirements analysis, and a cost-effectiveness and affordability analysis. There was no comparison of alternatives. This report served as their AOA.	High
MP RTIP – Multi-Platform Radar Technology Insertion Program	The Radar Technology Insertion Program was initially a Previously Planned Product Improvement for the Joint STARS aircraft.	Low
NMT – Advanced Extremely High Frequency Navy Multiband Terminal Satellite Program	This NMT program began as an ACAT II, and ACAT II programs are not required to have AOAs at program start.	Low
SBSS B10 – Space-Based Space Surveillance Block 10	An AOA was not conducted because of the Air Force's direction to quickly develop and field a replacement for the current satellite surveillance system in order to prevent an operational capability gap.	Low
SKY WARRIOR – Unmanned Aircraft System	The Army had already made the decision to procure an unmanned aerial system. The Army argued, among other things, that the source selection process would drive competitive selection of alternatives.	High
SM-6 – Standard Missile-6	No AOA was conducted because several analyses were completed for previous iterations of the program.	Low

Source: GAO analysis of data provided by DOD program offices.

<sup>a</sup> Cost growth: High = 25 percent or greater growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Moderate = 10 to 24 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Low = less than 10 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates.

Schedule growth: High = greater than 12 month delay for the initial operational capability date or acquisition cycle, Moderate = 7 to 12 month delay for the initial operational capability date or acquisition cycle, Low = less than 7 month delay for the initial operational capability date or acquisition cycle.

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However, in the other 3 programs that did not have AOAs, the requirements and development effort proved to be more demanding and cost and schedule growth occurred. In the case of the Army's Sky Warrior Unmanned Aerial System (UAS) program, an Army executive waived the AOA requirement because the Army believed, among other things, that the source selection process would provide an adequate way to compare alternatives. However, when the Air Force and Joint Staff were reviewing the Sky Warrior's draft requirements and acquisition documentation, they raised concerns that the requirements potentially duplicated capability provided by the Air Force's Predator UAS. The Army cited the urgent need of battlefield commanders for the capability and gained approval to proceed to source selection. Three years after the Sky Warrior AOA was waived, the Deputy Secretary of Defense directed that the two UAS programs be combined into a single acquisition program to achieve efficiencies in areas such as common development, procurement, and training activities. However, the Army and Air Force have continued to pursue unique systems. In the meantime, the Sky Warrior UAS has experienced a 138 percent increase in total cost and 47-month schedule delay from original plans. By relying on industry-provided information in source selection and not conducting an independent AOA, the Army missed an opportunity to gain a better understanding of the other services' UAS capabilities, and pursue an acquisition strategy that would have taken advantage of commonalities and used resources more efficiently.

#### Programs That Conducted AOAs

Of the 22 programs that conducted AOAs, 13 focused on a limited number of alternatives within a single weapon system concept while 9 focused on many alternatives<sup>9</sup> (see table 3). According to DOD and service officials, the scope of an AOA can be different for each program and dependent upon many factors, including the nature of the capability need, the proposed time frame for fielding the capability, and the type of program being pursued—whether it is a new development start, a modification of a commercially available system, or an upgrade to an existing system. As a result, AOAs that focus on a limited number of alternatives within a single weapon system concept may be appropriate in some cases. For instance,

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<sup>9</sup> Although DOD has no specific criteria for how many alternatives are to be considered in an AOA, Air Force guidance indicates that AOAs should consider a comprehensive set of alternatives representing all reasonable solutions. For the AOAs we reviewed, we categorized “limited” number of alternatives as AOAs that examined two to five alternatives within a single weapon system concept and “many” alternatives as AOAs that examined eight or more alternatives within a single weapon system concept or alternatives across multiple weapon system concepts.

when the capability need was defined in terms of upgrading an existing weapon system, AOAs focused on refining a single platform concept and its system-level specifications and attributes. The AOA for the Army's Apache Block III program is an example of an appropriately, but narrowly scoped AOA. It examined various block upgrade options for the existing Longbow Apache helicopter to improve interoperability and other shortcomings in the helicopter. The program started development in 2006 and has remained on track with its planned cost and schedule objectives.

**Table 3: Scope of Alternatives Considered in AOAs**

<b>AOAs with narrow scope of alternatives<sup>a</sup></b>	<b>Cost or schedule growth (low, moderate, or high)<sup>b</sup></b>	<b>AOAs with broad scope of alternatives<sup>a</sup></b>	<b>Cost or schedule growth (low, moderate, or high)<sup>b</sup></b>
AGM-88E AARGM – AGM-88E Advanced Anti-Radiation Guided Missile (AARGM) Program	Low	BAMS – Broad Area Maritime Surveillance	High
AB3 – Apache Block III	Low	EA-18G – Electronic attack variant of the F/A-18 aircraft	Low
ARH – Armed Reconnaissance Helicopter	High	CH-53K – Heavy Lift Replacement Program	Low
CVN 21 – Next Generation Nuclear Aircraft Carrier	Moderate	JCA – Joint Cargo Aircraft	Low
DDG 1000 – ZUMWALT CLASS Destroyer	High	JLENS – Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System	Low
E-2D AHE – E-2D Advanced Hawkeye	High	LUH – Light Utility Helicopter	Low
FCS – Future Combat Systems	High	MUOS – Mobile User Objective System	Moderate
JTRS AMF – Joint Tactical Radio System Airborne, Maritime/Fixed Station	Low	P-8A – Poseidon Program	Low
LCS – Littoral Combat Ship	High	SDB I – Small Diameter Bomb Increment I	Low
LHA REPLACEMENT – New Amphibious Assault Ship	Low		
MPS – Mission Planning System	High		
VH-71 – Presidential Helicopter Fleet Replacement Program	High		
WIN-T – Warfighter Information Network – Tactical	High		

Source: GAO analysis of data provided by DOD program offices.

<sup>a</sup> Narrow scope of alternatives = 2-5 alternatives within one concept; broad scope of alternatives = 8-26 alternatives within one concept, or alternatives within multiple concepts.

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<sup>b</sup> Cost growth: High = 25 percent or greater growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Moderate = 10 to 24 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Low = less than 10 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates.

Schedule growth: High = greater than 12 month delay for the initial operational capability date or acquisition cycle, Moderate = 7 to 12 month delay for the initial operational capability date or acquisition cycle, Low = less than 7 month delay for the initial operational capability date or acquisition cycle.

In a few of the other AOAs that had a narrow scope, the capability need involved the replacement of an aging weapon system and the AOAs presumed that the concept of the aging weapon system was the appropriate starting point for analysis rather than examining whether other concepts could also meet the need. For example, the AOA for the Army's Armed Reconnaissance Helicopter (ARH) program, which was intended to replace the aging Kiowa helicopter fleet and improve attack and reconnaissance capabilities, examined two options: improving the legacy Kiowa helicopter or procuring nondevelopmental helicopters. The AOA did not explore other potential solutions, such as developing unmanned aerial systems, increasing the purchase of existing attack helicopters, increasing the purchase of other reconnaissance assets, or relying on a mix of solutions. After 3 years of development, the ARH program's research and development costs increased from about \$360 million to \$940 million. A Center for Naval Analyses report commissioned by the Army after the ARH program began having execution problems identified several factors that contributed to the significant cost growth, including questionable requirements, an aggressive schedule, limited oversight, and a perceived preference for one helicopter model. As a result of the cost growth and other problems, DOD cancelled the program in 2008 after determining that at least one alternative could provide equal or greater capability at less cost.

Most of the programs (7 of 9) that examined a broad scope of alternatives have tracked well with their planned cost and schedule targets. The AOA for the Navy's P-8A Multi-mission Maritime Aircraft, which is a program designed to replace the P-3C aircraft and provide maritime patrol and reconnaissance for the Navy, explored multiple concepts and many alternatives in response to study guidance issued by OSD PA&E, including several nonmanned aircraft alternatives such as submarines, helicopters, and UAS. The AOA concluded that a manned aircraft would still be the best option to replace the P-3C. However, the AOA also helped the Navy to recognize that a UAS could perform some of the maritime patrol missions as an adjunct platform, eventually leading to the Broad Area Maritime Surveillance (BAMS) UAS AOA and program. The P-8A program has not

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experienced cost growth over its 4 years of development and remains on schedule. Similarly, the Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS), which is designed to provide over the horizon detecting and tracking of land attack cruise missile and other targets, had an AOA that explored alternatives across multiple concepts, including aerostat sensors, sea-based sensors, and nonaerostat elevated sensors. The Army chose the aerostat concept and has developed an incremental program that has experienced low cost and schedule growth since starting development in 2005.

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### Many AOAs Have Not Adequately Assessed Risks for the Alternatives

DOD acquisition policy requires that AOAs assess the technical risk of alternatives, but it does not provide criteria and guidance for how and to what extent technical risks should be addressed and it does not specify that other types of risks should be assessed.<sup>10</sup> Risks are important to assess because there may be technical, programmatic, or operational uncertainties associated with different alternatives that should be considered in determining the best weapon system approach. For example, it may be the case that one alternative is more effective than another in meeting a capability need but has more technical or other risks that may make the alternative infeasible to develop. Many of the AOAs we reviewed (12 of the 22) conducted limited assessments of the risks of each alternative presented (see table 4).<sup>11</sup> Some AOAs we reviewed did not examine risks at all, focusing only on the operational effectiveness and costs of alternatives. Other AOAs had relatively limited risk assessments. For example, several AOAs did not discuss integration risks even though they were examining modified commercial systems that required the integration of subsystems or equipment packages, while other AOAs did not examine the schedule risks of the various alternatives, despite accelerated schedules and fielding dates for the programs. We found that programs with AOAs that conducted a more comprehensive assessment of

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<sup>10</sup> While DOD acquisition policy (DODI 5000.2) indicates that an AOA shall assess technology risk and maturity, Air Force guidance for conducting AOAs advocates that programmatic and operational risks should be considered as well. The Air Force guidance indicates that AOA study teams should determine, as a first step in conducting a risk analysis, what technical, programmatic, and operational factors are relevant to each alternative. For example, open architecture, schedule, overarching dependencies, and maintenance requirements may be important risk factors for some AOAs.

<sup>11</sup> We defined “limited” risk assessments as AOAs that did not examine risks at all or examined only one risk factor such as technology maturity. We defined AOAs as having a more robust risk assessment if they examined multiple risk factors such as technology, integration, and schedule.

risks tended to have better cost and schedule outcomes than those that did not (see table 5).

**Table 4: Risk Assessment of AOAs by Program**

<b>AOAs with no or limited assessment of risks<sup>a</sup></b>	<b>Cost or schedule growth (low, moderate, or high)<sup>b</sup></b>	<b>AOAs with adequate assessment of risks<sup>a</sup></b>	<b>Cost or schedule growth (low, moderate, or high)<sup>b</sup></b>
AGM-88E AARGM – AGM 88E Advanced Anti-Radiation Guided Missile (AARGM) Program	Low	BAMS – Broad Area Maritime Surveillance	High
AB3 – Apache Block III	Low	DDG 1000 – ZUMWALT CLASS Destroyer	High
ARH – Armed Reconnaissance Helicopter	High	EA-18G – Electronic attack variant of the F/A-18 aircraft	Low
CVN-21 – Next Generation Nuclear Aircraft Carrier	Moderate	CH-53K – Heavy Lift Replacement Program	Low
E-2D AHE – E-2D Advanced Hawkeye	High	JCA – Joint Cargo Aircraft	Low
FCS – Future Combat Systems	High	JTRS AMF – Joint Tactical Radio System Airborne & Maritime/Fixed Station	Low
JLENS – Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System	Low	LUH – Light Utility Helicopter	Low
LCS – Littoral Combat Ship	High	MUOS – Mobile User Objective System	Moderate
LHA REPLACEMENT – New Amphibious Assault Ship	Low	P-8A – Poseidon Program	Low
MPS – Mission Planning System	High	SDB I – Small Diameter Bomb Increment I	Low
VH-71 – Presidential Helicopter Fleet Replacement Program	High		
WIN-T – Warfighter Information Network – Tactical	High		

Source: GAO analysis of data provided by DOD program offices.

<sup>a</sup> No assessment = no discussion in AOA of technical, integration, or other risks; limited assessment = only technical risk addressed or not all of the alternatives are assessed for technical and other risks; adequate assessment = all alternatives are assessed for multiple factors such as technical, integration, and other risks.

<sup>b</sup> Cost growth: High = 25 percent or greater growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Moderate = 10 to 24 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Low = less than 10 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates.

Schedule growth: High = greater than 12 month delay for the initial operational capability date or acquisition cycle, Moderate = 7 to 12 month delay for the initial operational capability date or acquisition cycle, Low = less than 7 month delay for the initial operational capability date or acquisition cycle.

**Table 5: Comparison of Quality of AOA Risk Assessments and Program Cost and Schedule Growth**

Quality of risk assessment <sup>b</sup>	Number of programs with cost or schedule growth <sup>a</sup>		
	Low	Moderate	High
AOAs with no or limited assessment of risks	4	1	7
AOAs with adequate assessment of risks	7	1	2

Source: GAO.

<sup>a</sup> Cost growth: High = 25 percent or greater growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Moderate = 10 to 24 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates, Low = less than 10 percent growth in development cost (or procurement costs for nondevelopmental programs) from initial baseline to current estimates.

Schedule growth: High = greater than 12 month delay for the initial operational capability date or acquisition cycle, Moderate = 7 to 12 month delay for the initial operational capability date or acquisition cycle, Low = less than 7 month delay for the initial operational capability date or acquisition cycle.

<sup>b</sup> No assessment = no discussion in AOA of technical, integration, or other risks; limited assessment = only technical risk addressed or not all of the alternatives are assessed for technical and other risks; adequate assessment = all alternatives are assessed for multiple factors such as technical, integration, and other risks.

AOAs that do not examine risks could provide overly optimistic assessments of alternatives, which do not provide for sound business case decisions. Comparing risks across alternatives is especially critical for new development programs, which rely on breakthrough technologies and assume that technology will be achieved as planned. Of the 22 programs that had AOAs, 8 were new development starts involving technology development. Of the 8 new development starts, only 4 had AOAs that performed adequate risk analyses. The other 4 AOAs did not assess technical, integration, or other risks as criteria for comparing the alternatives or neglected to analyze these risks altogether. For example, the AOA for the Future Combat Systems (FCS), one of most complex and technically challenging programs ever undertaken according to the Army,

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assessed the technical risks of each of the new development concepts for FCS, but did not assess and compare the risks with those of the other alternatives. The AOA concluded that the new FCS development option was more costly but more operationally effective than the baseline and improved baseline alternatives.<sup>12</sup> By not comparing the risks of the alternatives, the FCS AOA missed an opportunity to provide the Army with a meaningful trade off among operational effectiveness, costs, and risks. Now, after 6 years of development, some of the critical technologies for the FCS program are still immature. The latest estimates for the program show that development costs have grown 38 percent or about \$8 billion, and the fielding date has been delayed 57 months. As a result, DOD recently proposed canceling the FCS acquisition program.

Also, the AOA for the Army's Warfighter Information Network-Tactical (WIN-T) program, which involves development of new on-the-move networking capabilities, did not address technical or programmatic risks. Army officials stated that WIN-T was largely based on a concept that did not have well-defined requirements of the proposed network and operations, and the WIN-T development alternative in the AOA was based on preliminary design concepts, from two competing contractors, which were blended together by the Army. The AOA did not take these risks into account and concluded that the new WIN-T alternative was the most operational and cost-effective solution available. In March of 2007, the WIN-T program had a Nunn McCurdy cost breach (25 percent or more unit cost growth) and was subsequently restructured by DOD. Insufficient technical readiness was cited as one of the key factors leading to the cost breach.

Assessing risks is also important for programs based on commercial products that require significant modifications. Based upon a recent Defense Science Board report on buying commercially-based defense systems, programs that do not assess the systems engineering and programmatic risks of alternatives do not understand the true costs associated with militarizing commercial platforms or integrating various

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<sup>12</sup> The AOA for the FCS program examined the following seven alternatives: Base Case – Heavy Force, Base Case – Light Force, Base Case – Interim Force, FCS – Block II, FCS – Block I, FCS – Increment 1, Product Improved Stryker Brigade Combat Team.

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commercial components.<sup>13</sup> As a result of this incomplete understanding of inherent technical and integration risks of programs, DOD fails to fully take advantage of efficiencies and cost savings from commercially available technologies. Several of the programs we reviewed that involved modified commercial products had AOAs with weak risk assessments. For example, the AOA for the Marine Corps' replacement for the Presidential Helicopter, VH-71, failed to assess the technical, integration, and schedule risks associated with its three alternatives. It instead compared alternatives based on costs and performance attributes, such as cabin size, deployability, and performance. One program official stated that the focus of the VH-71 AOA was to merely identify platforms that had the best probability of meeting the requirements. According to a statement by the Secretary of Defense, the program's costs have nearly doubled, increasing from \$6.5 billion to \$13 billion, and the schedule has fallen behind by several years. DOD recently cancelled the program. The Defense Science Board, which assessed the VH-71 program, concluded that some of the program's requirements plainly exceeded the limits of the available technology and schedule.

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## Choosing an Alternative Too Early and Conducting AOAs under Compressed Time Frames and without Effective Guidance Limit the Scope and Quality of AOAs

We identified several factors that may have limited the effectiveness of AOAs and their ability to identify the most promising option and contribute to a sound business case for starting a weapon system program: (1) service sponsors lock into a solution early on when a capability need is first validated through DOD's requirements process and before an AOA is conducted; (2) AOAs are conducted under compressed time frames in order to meet a planned milestone review or fielding date and their results come too late to inform key trade off decisions; and (3) DOD does not always provide guidance for conducting individual AOAs. The AOAs with one or more of these factors tended to be AOAs that had a limited scope and assessment of risks (see table 6).

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<sup>13</sup> Defense Science Board, *Buying Commercial: Gaining the Cost/Schedule Benefits for Defense Systems. Report of the Defense Science Board Task Force on Integrating Commercial Systems into the DOD, Effectively and Efficiently* (Washington, D.C.: February 2009).

**Table 6: Factors Associated with AOAs That Had Different Scope and Risk Assessments**

	<b>Choosing an alternative too early</b>	<b>Problematic timing</b>	<b>No or late PA&amp;E guidance</b>
AOAs with limited scope and risk assessments	ARH – Armed Reconnaissance Helicopter CVN 21 – Next Generation Nuclear Aircraft Carrier FCS – Future Combat Systems LCS – Littoral Combat Ship	AB3 – Apache Block III ARH – Armed Reconnaissance Helicopter CVN 21 – Next Generation Nuclear Aircraft Carrier FCS – Future Combat Systems LCS – Littoral Combat Ship VH-71 – Presidential Helicopter Fleet Replacement Program WIN-T – Warfighter Information Network-Tactical	AGM-88E AARGM – AGM-88E Advanced Anti-Radiation Guided Missile (AARGM) Program E-2D AHE – E-2D Advanced Hawkeye FCS – Future Combat Systems LCS – Littoral Combat Ship MPS – Mission Planning System VH-71 – Presidential Helicopter Fleet Replacement Program
AOAs with broad scope and adequate risk assessments	CH-53K – Heavy Lift Replacement Program LUH – Light Utility Helicopter	CH-53K – Heavy Lift Replacement Program LUH – Light Utility Helicopter	BAMS – Broad Area Maritime Surveillance CH-53K – Heavy Lift Replacement Program SDB I – Small Diameter Bomb Increment I

Source: GAO analysis of data provided by DOD program offices.

**Service Sponsors Lock Into a Program Solution or Establish Requirements Prior to the AOA**

In developing a capability proposal, sponsors not only justify the need to fill an existing capability gap, but also conduct an assessment—called a functional solutions analysis (FSA)—to identify a potential concept or set of solutions to fill the gap. The identification of a potential concept is intended to provide a general approach for addressing the gap and set the stage for a more in-depth assessment of alternatives to be conducted in the AOA. In four cases, AOAs were limited because program sponsors had decided on a preferred solution prior to the AOA, when a capability need was first proposed through the department’s requirements determination process. Approval of the capability proposal then led to a narrowly scoped AOA that supported or refined the preferred solution. According to DOD officials, the analysis supporting a capability proposal is generally conducted by the operational requirements community within a military service and contains only rudimentary assessments of the costs and technical feasibility of the solutions identified.

With the Armed Reconnaissance Helicopter program, for example, the Army proposed acquiring an armed reconnaissance helicopter after the termination of the Comanche helicopter program, which had experienced

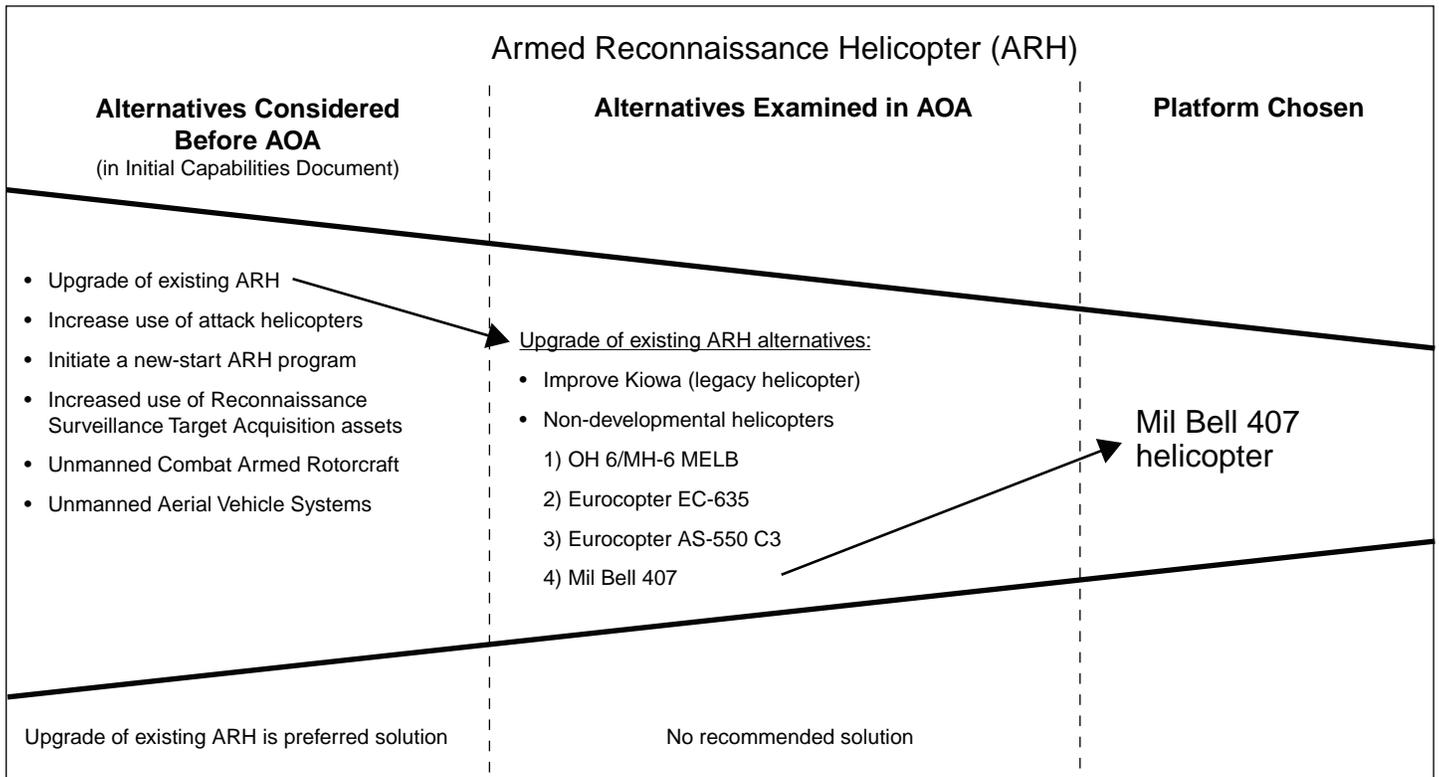
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significant cost and schedule problems.<sup>14</sup> While the initial capability proposal submitted to JCIDS for the ARH considered nonhelicopter concepts, such as unmanned aerial systems, the Army concluded that a modified version of an existing armed reconnaissance helicopter was the preferred solution. According to Army officials, the modified helicopter solution was pushed in part because there was a desire to field a system within a relatively short time frame, a similar helicopter variant was in use by the special operations forces, and funding available from the terminated Comanche helicopter program needed to be used quickly. Because the Army effectively locked into a solution in this early stage, the AOA primarily focused on comparing the performance and costs of existing helicopter alternatives (see fig. 2).

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<sup>14</sup> The termination of the Comanche helicopter program provided the Army the opportunity to redirect its resources to fund a broad range of programs and activities, including the Armed Reconnaissance Helicopter, which is intended to address numerous shortcomings in the reconnaissance helicopter fleet.

**Figure 2: Alternatives Considered for the ARH Program**



Source: GAO presentation of DOD data.

Similarly, we have previously reported<sup>15</sup> that the Navy began the Littoral Combat Ship (LCS) program before fully examining alternatives. Beginning in 1998, the Navy conducted a series of wargames and studies to test new concepts for surface combatant ships that could address known threats in littoral areas. Following these efforts, the Navy began an analysis of multiple concepts study<sup>16</sup> in 2002 to further refine the Navy's preferred solution—a new warship along the lines of LCS. Concurrently, the Navy established an LCS program office and issued a request for

<sup>15</sup> GAO, *Defense Acquisitions: Plans Need to Allow Enough Time to Demonstrate Capability of First Littoral Combat Ships*, GAO 05-255 (Washington, D.C.: Mar. 1, 2005).

<sup>16</sup> The Navy conducted an Analysis of Multiple Concepts, one of the studies required by DOD acquisition policy in 2002 for program initiation, which was subsequently approved by OSD PA&E as a tailored AOA.

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proposal to industry to submit LCS concepts. The Office of the Secretary of Defense and the Joint Staff were concerned that the Navy's focus on a single solution did not adequately consider other ways to address littoral capability gaps. Based on these concerns in late 2003, the Navy was directed to consider alternatives to surface ships such as submarines and manned aircrafts in the ongoing analysis of multiple concepts. The analysis, which was led by the Naval Surface Warfare Center, compared nonship alternatives to LCS-concept ships and concluded that the LCS concept remained the best solution to provide capabilities in the littorals. However, the estimated costs for the various LCS ship alternatives developed in the analysis far exceeded the \$220 million (fiscal year 2005 dollars) target that the Navy had set for the program. The Navy stated that because the cost estimates were rough-order-of-magnitude estimates and were based on preliminary concept designs, those costs were not used to make cost decisions for LCS. However, since starting development in 2004, the LCS program has experienced a 151 percent growth in development costs and its costs are closer to the cost estimates from the analysis of multiple concepts than the target cost set by the Navy.

DOD and service officials responsible for conducting AOAs indicated that often capability requirements are proposed that are so specific that they effectively eliminate all but the service sponsor's preferred concepts instead of considering other alternatives. For example, in recent proposals to address a global strike capability need, two components of the Air Force—the Air Combat Command and Space Command—defined initial performance requirements that required two different approaches. The Air Force Air Combat Command defined the requirement as the ability to strike a target within 1 day, which meant that bombers, which fall under the Air Force Air Combat Command's portfolio, could address the gap. However, the Air Force Space Command defined the requirement in the capability proposal as the ability to strike a target within a certain number of hours, which meant only missiles, which fall under the Air Force Space Command, could fulfill the need. Although OSD PA&E attempted to get the Air Force to consider both bombers and missiles in the same analysis, the major commands argued that their requirements were different enough to require two separate analyses. As a result, the Air Force Air Combat Command initiated the Next Generation Long-Range Strike AOA for a new bomber, while the Air Force Space Command initiated the Prompt Global Strike AOA separately.

Similarly, for the ARH AOA, the Army called for very specific deployability requirements. These requirements included the ability to fit two helicopters into a C-130 aircraft and for the helicopter to be "fightable"

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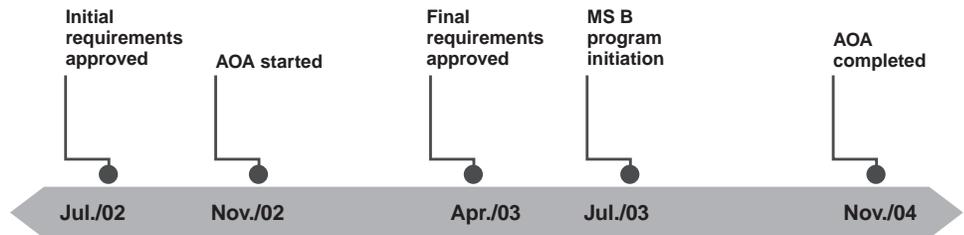
within 15 minutes of arrival. The Center for Naval Analyses, in its report on the factors that led to significant cost and schedule growth in the ARH program, noted that it was not clear whether these requirements were needed to fulfill the operational gap. Furthermore, the Center for Naval Analyses noted that due to the stringent deployability requirements, the program had effectively eliminated other potentially feasible and cost-effective alternatives, such as twin-engine helicopters, and limited the analysis to single engine alternatives.

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### Timing of AOAs May Not Be Conducive to Informing Trade Offs

Many AOAs are also conducted under compressed time frames—6 months or less—or concurrently with other key activities that are required for program initiation, in order to meet a planned milestone decision or weapon system fielding date. Consequently, AOAs may not have enough time to assess a broad range of alternatives and their risks, or be completed too late in the process to inform effective trade discussions prior to beginning development. In 9 of the 22 programs we reviewed that had AOAs, the timing of the AOAs was compressed or concurrent with other planning activities. In 7 of these 9 programs, the AOAs were limited. For instance, the AOA for the Future Combat Systems program was a complex undertaking; however, according to the authors of the AOA, it was conducted in half the time that a less complex AOA would typically be conducted. In addition, due to schedule constraints imposed to meet a preset milestone review date, the AOA was performed concurrently with concept development, requirements determination, and system definition documents. Ultimately, the Future Combat Systems AOA was completed 1 month after the operational requirements were validated and the same month that the program was approved to begin system development, which precluded trade off discussions among cost, performance, and risks from taking place. In addition, although AOAs are required to be done for a Milestone B decision, the Army's Warfighter Information Network-Tactical (WIN-T) program was approved to begin without one. The milestone decision authority for the program waived the AOA requirement until a later date. The WIN-T AOA was completed approximately 16 months after the program started (see fig. 3).

**Figure 3: Milestones for WIN-T Program**



Source: GAO presentation of DOD data.

## DOD Has Not Consistently Provided Guidance for Conducting Individual AOAs

While DOD acquisition policy<sup>17</sup> requires that major defense acquisition programs conduct an AOA prior to program initiation at Milestone B, the policy does not specify criteria or guidance for how AOAs should be conducted. According to the policy, OSD PA&E is to provide guidance to programs prior to, during, and after their AOA has been completed. The guidance is intended to ensure that the services are examining a sufficient number of alternatives that take into consideration joint plans and interoperability, but to also ensure that AOAs are analyzing key risks such as technology, cost, and schedule. In 9 of the 22 programs we reviewed that had AOAs, OSD PA&E either provided late guidance or did not provide formal guidance when AOAs were started. In 6 of these 9 programs, the AOAs were limited. For instance, OSD PA&E did not provide guidance for the AOA that supported initiation of the VH-71 Presidential Helicopter program. In this AOA, the service had very specific performance requirements that narrowed the scope of the alternatives examined. In addition, the service conducted the AOA under a compressed schedule to meet a previously planned milestone, which may not have allowed for robust analyses of technology and integration risks. These factors most likely played a part in the AOA examining only 3 alternatives and eliminating 19 other alternatives early on.

DOD officials have also stated that when OSD PA&E guidance is provided, it is sometimes late. For example, the LCS program AOA had been underway for about a year before OSD PA&E provided guidance to the Navy. Officials also explained that guidance is often informal, sometimes

<sup>17</sup> DOD's acquisition policy is contained in DOD Instruction 5000.2, the *Operation of the Defense Acquisition System*.

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provided over the telephone, or if written, remains in draft form for long periods, preventing the services from formulating and having analysis plans approved. However, according to PA&E officials, sometimes guidance is never formalized or written because the services do not have a validated capability proposal or do not agree with the scope and direction provided. By not providing timely formal guidance before AOAs are started, DOD is missing an opportunity to ensure AOAs examine an appropriate scope of alternatives and conduct robust risk assessments.

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## Recent DOD Policy Changes Could Improve AOA Effectiveness

In December 2008, DOD revised its acquisition policy and introduced several initiatives based in part on direction from Congress that could provide a better foundation for establishing knowledge-based business cases for initiating weapon system programs. The revised policy strengthens the front end of the acquisition process by requiring key systems engineering activities and early prototyping, and establishing required milestone reviews to assess whether programs are acquiring the requisite knowledge as they move towards the start of system development. In addition, in March 2009, DOD revised its policy governing the JCIDS process, to help streamline the determination of capability needs and improve the integration between JCIDS and the acquisition process. In revising these policies, DOD elevated the role of AOAs in determining weapon system concepts and strengthened how they are to be implemented. Improving the effectiveness of AOAs will depend on DOD's ability to ensure that its policy changes are consistently implemented and reflected in decisions on individual weapon system programs. We have reported in the past that inconsistent implementation of existing policies has hindered DOD's efforts to plan and execute programs effectively.<sup>18</sup> The key revisions to the policies that impact AOAs are summarized in table 7.

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<sup>18</sup> GAO, *Defense Acquisitions: DOD Must Balance Its Needs with Available Resources and Follow an Incremental Approach to Acquiring Weapon Systems*, [GAO-09-431T](#) (Washington, D.C.: Mar. 3, 2009).

**Table 7: Policy Revisions That Affect AOAs**

<b>DOD 5000.2 (May 2003 Revision)</b>	<b>DOD 5000.02 (December 2008 Revision)</b>	<b>Differences</b>
AOA required by regulation for Major Defense Acquisition Programs.	AOA required by statute for Milestone B certification.	Policy now reflects congressional legislation passed in 2006 that requires the milestone decision authority to certify to Congress that programs approved at MS B have, among other things, conducted an AOA.
AOA to be conducted during concept refinement phase leading up to Milestone A review that may be waived.	AOA to be conducted during Materiel Solution phase leading up to Milestone A review that must be certified by the milestone decision authority.	Policy now places greater emphasis on Milestone A. This should help ensure AOAs are conducted earlier.
Focus of the AOA is to refine the selected concept documented in the approved capability proposal document.	AOA is to assess potential materiel solutions to satisfy the capability need.	AOA intended now to conduct broader examination of alternatives.
PA&E to provide guidance prior to the start of AOA.	PA&E to provide AOA guidance for approval by the milestone decision authority.	AOA guidance now required to be approved by milestone decision authority.
AOA study plan to be prepared for review by PA&E.	AOA study plan to be approved by PA&E.	AOA study plan must now be approved by PA&E.
AOA shall assess the critical technologies associated with concepts, including technology maturity, technical risk, and, if necessary, technology maturation and demonstration needs.	The AOA shall assess the critical technology elements associated with each proposed materiel solution, including technology maturity, integration risk, manufacturing feasibility, and, where necessary, technology maturation and demonstration needs.	Policy broadens the focus of AOA risk assessments to include integration risk and manufacturing feasibility.
<b>Chairman of the Joint Chiefs of Staff Instruction 3170.01F (May 2007 Revision)</b>	<b>Chairman of the Joint Chiefs of Staff Instruction 3170.01G (March 2009 Revision)</b>	<b>Differences</b>
If a materiel solution is needed, sponsor identifies a potential solution or set of solutions to fill a capability gap.	If a materiel solution is needed, sponsor will make recommendation on the broad type of materiel solution preferred—information system, evolutionary development of an existing capability, or a transformational approach.	Policy change should help mitigate sponsors identifying a preferred solution early on in a proposed capability document.

Source: GAO analysis of DOD 5000 and CJCSI 3170 policies.

DOD’s revised policies, for example, may help mitigate service sponsors from locking into a solution too early in the process by eliminating the functional solutions analysis in a capability proposal, which identified a preferred solution and influenced the scope of alternatives in an AOA. In the revision, the capability proposal will only identify a broad category of the type of materiel solution that should be considered; for example, whether it should be an incremental or transformational development approach. The AOA will then assess potential solutions as determined by the milestone decision authority and within the broad category

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recommended. This change integrates essentially what had been two separate trade space analyses into one analysis. In doing so, it sets up a better opportunity for a more robust analysis of alternatives.

DOD's revised acquisition policy also now imposes early milestone reviews which should help resolve the timing issues we found with several AOAs in the past. Under the previous policy, AOAs were required for program initiation at Milestone B, which may have led to some AOAs being completed just prior or even after program initiation. Under the revised policy, AOAs are generally required earlier in the process. Furthermore, DOD PA&E is required to be involved much earlier in the process by providing requisite guidance at the Materiel Development Decision as well as approving AOA study plans before an AOA is started. These additional reviews with required guidance earlier in the acquisition process should help mitigate conducting AOAs under compressed time frames. However, while the revised policy strengthens the front end of the acquisition process, the AOA is still constrained to a given set of requirements that may be unfeasible and could lead to unsuccessful program outcomes, such as with the Armed Reconnaissance Helicopter and Future Combat Systems.

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## Conclusions

With increased demand and competition for funding, it is critical that DOD weapon system programs provide the best value to the warfighter and to the taxpayer. Yet in too many cases, DOD programs do not accomplish this and experience significant cost, schedule, and performance problems. Many of these problems could be avoided if programs started with sound, knowledge-based business cases. A key to developing such business cases is having effective AOAs that analyze and compare the performance, costs, and risks of competing solutions, and identify the most promising weapon system solution to acquire. The majority of AOAs we reviewed were limited and thus did not sufficiently inform the business case for starting new programs.

DOD's recent policy revisions are positive steps that could, if implemented properly, provide a better foundation for conducting AOAs and establishing sound business cases for starting acquisition programs. The revisions, for example, should help ensure that DOD direction is provided before AOAs are started and that AOAs are conducted at an early point in the acquisition process where their results can inform key decisions affecting program initiation. However, these policy changes alone will not be sufficient to ensure AOAs achieve their intended objectives. Unless mechanisms are established to ensure policy is followed, specific guidance

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and criteria are developed for how AOAs should be conducted, and AOAs are completed before program requirements are set, AOAs will not provide effective in-depth analyses and DOD will continue to struggle to make informed trade offs and start executable programs.

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## Recommendations for Executive Action

To further strengthen the effectiveness of AOAs in helping DOD establish sound business cases for major weapon programs, we recommend that the Secretary of Defense take the two following actions:

- Establish specific criteria and guidance for how AOAs should be conducted, including how technical and other programmatic risks should be assessed and compared.
- Ensure that AOAs are completed and approved before program requirements—key performance parameters and attributes—are finalized and approved.

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## Agency Comments and Our Evaluation

In written comments on a draft of this report, DOD concurred with our recommendations. DOD's response is reprinted in appendix II. DOD stated in response to our first recommendation that it had made significant progress in establishing criteria and guidance for conducting AOAs, and in defining the relationship/role of the AOA in both the acquisition and capabilities determination processes. DOD indicated that the role of the AOA has been defined in recently revised acquisition policy (Department of Defense Instruction 5000.02, dated Dec. 2, 2008) and capabilities policy (Chairman, Joint Chiefs of Staff Instruction 3170.01G, dated Mar. 1, 2009). While we agree that promising improvements have been made in revising the policies, they do not go far enough in providing specific criteria and guidance for how AOAs should be conducted. Without such direction, there is a risk that AOAs will continue to provide limited assessments of weapon system options, and DOD will initiate programs without sound, executable business cases. In concurring with our second recommendation—that AOAs be completed before requirements are finalized—DOD pointed out that under its revised acquisition policy, AOAs are now required to be completed before the formal initiation of an acquisition program. We agree that the policy should help improve the timing of AOAs so that they are conducted at an early point in the acquisition process and provide an opportunity for trade offs to take place. However, establishing and approving requirements is another key step required for initiating an acquisition program and this is done under a separate process—the Joint Capabilities Integration and Development System. We believe that DOD needs to take steps to ensure that program

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requirements are not finalized before the AOA is completed and that the results of the AOA are used to inform the setting of requirements.

DOD also provided technical comments, which we incorporated where appropriate.

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As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the Secretary of Defense; the Secretaries of the Air Force, Army, and Navy; and interested congressional committees. This report will also be available at no charge on the GAO Web site at <http://www.gao.gov>.

If you have any questions about this report or need additional information, please contact me at (202) 512-4841 or [sullivanm@gao.gov](mailto:sullivanm@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix IV.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'Michael J. Sullivan', with a stylized flourish at the end.

Michael J. Sullivan, Director  
Acquisition and Sourcing Management

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# Appendix I: Scope and Methodology

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To assess whether analyses of alternatives (AOA) have been effective in identifying the most promising options and providing a sound rationale for program initiation, we analyzed data and documents for Acquisition Category (ACAT) I programs that have been initiated between fiscal years (FY) 2003 and 2008 and were in the Department of Defense's (DOD) FY 2008 Major Defense Acquisition Program (MDAP) list. The relevant policy that governs the AOA process for these programs, DOD Instruction 5000.2 (*Operation of the Defense Acquisition System*), was revised by DOD in May of 2003 and revised again in December of 2008 to become DOD Instruction 5000.02. As a result, we used the May 2003 DOD Instruction to assess the AOAs. Using DOD's FY 2008 MDAP list and Milestone B dates provided by DOD, we identified 34 ACAT I programs that had been initiated, or started system development and production, between 2003 and 2008. Programs that had been initiated between 2003 and 2008 but were not in the FY 2008 MDAP list, such as programs terminated before 2008, were not included in the analysis. We collected AOA full reports, executive summaries, guidance documents, and study plans when available, from program officials. Program officials also responded to data collection surveys we distributed through service action officers to gather information about their programs' AOA, guidance, capability documents, and how the AOA led to changes to the program concept. An official for the Cobra Judy Replacement program responded to the survey, but officials did not respond to several phone calls and e-mails requesting additional documentation, so this program was not included in the analysis. In addition, because the Combat Search and Rescue Replacement Vehicle (CSAR-X) program did not start development.

Of the remaining 32 programs, 10 programs did not have AOAs. Whether a program had an AOA or not was determined through analysis of program documents and survey responses. For the 22 programs that had AOAs, program documents and survey data were reviewed to determine the scope of the AOAs and whether the AOA assessed technology and integration risks. An AOA's scope was assessed to be narrow if the AOA examined 2 to 5 alternatives within a single concept and assessed to be broad if the AOA examined 8 to 26 alternatives within a single concept or multiple concepts. An AOA was assessed to have not completed any risk analyses for its alternatives when it made no mention of risks in the entire AOA report; assessed to be limited if the risk analyses were not completed for all of the alternatives, if integration risks were not examined, or if the risk analyses were not emphasized in the conclusions and recommendations; and assessed to be adequate if technical and integration risks were analyzed and compared for all of the alternatives. We followed up with some program officials through phone calls and e-mails for

additional information. To assess how the quality of AOAs correlates with programs' outcomes, we also collected program and cost data from DOD's Selected Acquisition Reports and GAO's Annual Assessments of Selected Weapon Programs. Programs with less than 10 percent cost growth were considered to have low cost growth, programs with 10 to 24 percent cost growth were considered to have moderate cost growth, and programs with 25 percent or more cost growth were considered to have high cost growth. Programs with less than 7 months of delay in initial operational capability or acquisition cycles were considered to have low schedule growth, programs with 7 to 12 months of delay in initial operational capability or acquisition cycles were considered to have moderate schedule growth, and programs with greater than 12 months of delay in initial operational capability or acquisition cycles were considered to have high schedule growth. The 32 programs we reviewed accounted for one third of the 96 programs in DOD's 2008 Major Defense Acquisition Program portfolio and approximately 22 percent of the total planned funding commitments.

To identify the factors that have affected the scope and quality of AOAs, we reviewed program documents, analyzed data from the survey, and reviewed DOD policy. We reviewed Initial Capabilities Documents (ICD) gathered from the Joint Staff's Knowledge Management/Decision Support tool and AOAs to determine how preferred solutions were carried from the requirements-generation process to the acquisition process. To determine how program schedules affected AOA scope and methodology, we analyzed AOA documents, program milestone dates, and AOA completion dates. To assess how DOD study guidance affected the quality of AOAs, we analyzed whether DOD provided guidance through survey responses and followed up with DOD to confirm those responses. We also reviewed regulations and policies issued by the Joint Staff, the military services, and DOD, as well as other DOD-produced documentation related to AOAs.

To determine what additional actions may be needed to address the limitations in the AOA process, we analyzed relevant DOD policies and federal statutes, including DOD Instruction 5000.2 (May 2003), DOD Instruction 5000.02 (December 2008), the Chairman of the Joint Chiefs of Staff Manual (CJCSM) 3170.01C (May 2007), CJCSM 3170.01 (March 2009), and Section 2366a of Title 10, United States Code.

In researching all three objectives, we interviewed officials from the U.S. Army G3; U.S. Army Training and Doctrine Command Analysis Center (TRAC); U.S. Army Capabilities Integration Center (ARCIC); U.S. Air Force Office of Aerospace Studies; Office of the Assistant Secretary for Acquisition, Deputy Assistant Secretary of the Air Force for Science,

Technology, and Engineering; Air Force Acquisitions - Global Reach; Deputy Assistant Secretary of the Navy, Acquisition and Logistics Management (A&LM); Deputy Directorate for Antiterrorism and Homeland Defense, J-34, Joint Staff; Office of the Secretary of Defense, Acquisition, Technology & Logistics; Office of the Secretary of Defense, Program Analysis and Evaluation; Office of the Deputy Under Secretary of Defense for Science and Technology (Acquisition and Technology)/Systems and Software Engineering; Armed Reconnaissance Helicopter Product Manager's Office; U.S. Army Aviation Center; Deputy Assistant Secretary of the Navy, Ship Programs; Littoral Combat Ship Program Office; Marine Corps Combat Development Command; Office of the Chief of Naval Operations, Deputy Chief of Naval Operations, Integration of Capabilities and Resources (N8), Director of Warfare Integration (N8F), Director of Surface Warfare (N86); Air Combat Command/A&I (Requirements), Secretary of the Air Force Technical and Analytical Support; and the Naval Surface Warfare Center, Dahlgren.

We conducted this performance audit from June 2008 to September 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

# Appendix II: Comments from the Department of Defense



ACQUISITION  
TECHNOLOGY  
AND LOGISTICS

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

SEP - 2 2009

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

Dear Mr. Sullivan:

This is the Department of Defense (DoD) response to the GAO draft report GAO-09-665, "DEFENSE ACQUISITIONS: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System Options," dated August 5, 2009 (GAO Code 120747).

The DoD concurs with both recommendations. The rationale for the DoD's position is enclosed.

We appreciate the opportunity to comment on the draft report. My point of contact for this effort is Mr. Ron Woods, 703-697-8183, [ronald.woods@osd.mil](mailto:ronald.woods@osd.mil).

Sincerely,

A handwritten signature in cursive script that reads "David G. Ahern for".

David G. Ahern  
Director  
Portfolio Systems Acquisition

Enclosure:  
As stated



GAO Draft Report Dated August 5, 2009  
GAO-09-665 (GAO CODE 120747)

“DEFENSE ACQUISITIONS: Many Analyses of Alternatives Have Not  
Provided a Robust Assessment of Weapon System Options”

DEPARTMENT OF DEFENSE COMMENTS  
TO THE GAO RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommends that the Secretary of Defense establish specific criteria and guidance for how analyses of alternatives should be conducted, including how technical and other programmatic risks should be assessed and compared.

DOD RESPONSE: Concur. DoD has already made significant progress in establishing the criteria and guidance for the conduct of an Analysis of Alternatives (AoA), and in defining the relationship/role of the AoA in both the acquisition and capabilities validation processes. The emergent role of the AoA has been defined as providing the key analytical foundation for assessing the utility of options available to the Department in addressing validated capability requirements by conducting an analysis that trades off cost, schedule, performance and risk (both mission and programmatic – to include technical risk) among the various alternative options. This role has been codified in the recently signed Department of Defense Instruction 5000.02, “Operation of the Defense Acquisition System,” dated December 2, 2008, and in the Chairman, Joint Chiefs of Staff Instruction, “Joint Capabilities Integration and Development System,” dated March 1, 2009. The Department is continuing to revise policy and procedures regarding the AoA in response to the recently enacted Weapon System Acquisition Reform Act of 2009.

RECOMMENDATION 2: The GAO recommends that the Secretary of Defense ensure that analyses of alternatives are completed and approved before program requirements-key performance parameters and attributes-are finalized and approved.

DOD RESPONSE: Concur. Guidance for the AoA, with the Director/Cost Assessment and Program Evaluation (D,CAPE) leading the development of the guidance, has become an accepted aspect of DoD guidance. The Material Development Decision (MDD) is now the mandatory entry point into the acquisition system with an approved Initial Capabilities Document and D,CAPE drafted AoA guidance as necessary entry conditions. The MDD occurs before the formal initiation of an acquisition program. The completed AoA is now required before the initiation of an acquisition program and should provide an analytically relevant process for assessing military utility, affordability and risk.

# Appendix III: Key Characteristics of AOAs

We surveyed 32 major defense acquisition programs on their analyses of alternatives process and outputs. Ten of the programs did not conduct AOAs. The following table provides characteristics of the 22 programs that conducted AOAs.<sup>1</sup>

**Table 8: Key Characteristics of Programs That Conducted AOAs**

Program	Acquisition category	Service sponsor	Organization conducting AOA	Type of organization	Length of AOA (in months)	Joint	Months between AOA completion and program start
AGM-88E AARGM – AGM-88E Advanced Anti-Radiation Guided Missile (AARGM) Program	IC	Navy	Center for Naval Analyses (CNA); Naval Air Warfare Center, China Lake	FFRDC and Service	Cannot be Determined	No	Cannot be Determined
AB3 – Apache Block III	ID	Army	Army’s TRADOC Analysis Center (TRAC)	Service	6	No	18
ARH – Armed Reconnaissance Helicopter	ID	Army	Army’s TRADOC Analysis Center (TRAC)	Service	6	No	6
BAMS – Broad Area Maritime Surveillance	ID	Navy	MITRE Corporation	FFRDC	15	No	55
CVN 21 – Next Generation Nuclear Aircraft Carrier	ID	OSD with Navy Support	Center for Naval Analyses (CNA)	FFRDC	46	Yes	52
DDG 1000 – ZUMWALT CLASS Destroyer	ID	Navy	Center for Naval Analyses (CNA)	FFRDC	39	No	92
E-2D AHE – E-2D Advanced Hawkeye	ID	Navy	Naval Research Lab and Whitney, Bradley & Brown, Inc.	Service and Contractor	32	No	7

<sup>1</sup> We removed the CSAR-X program from our analysis because the program was terminated before contracts were awarded.

**Appendix III: Key Characteristics of AOAs**

<b>Program</b>	<b>Acquisition category</b>	<b>Service sponsor</b>	<b>Organization conducting AOA</b>	<b>Type of organization</b>	<b>Length of AOA (in months)</b>	<b>Joint</b>	<b>Months between AOA completion and program start</b>
EA-18G – Electronic attack variant of the F/A-18 aircraft	ID	OSD with Navy Support	Various, including military and government agencies as well as the Johns Hopkins University Applied Physics Lab	Multiple Services, FFRDC and Contractor	29	Yes	24
FCS – Future Combat Systems	ID	Army	Army's TRADOC Analysis Center (TRAC)	Service	15	No	0
CH-53K – Heavy Lift Replacement Program	ID	Navy	Booz Allen Hamilton	Contractor	5	No	27
JCA – Joint Cargo Aircraft	ID	Army	Army's TRADOC Analysis Center (TRAC)	Service	9	No	24
JLENS – Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System	ID	Army	Army's TRADOC Analysis Center (TRAC)	Service	17	No	34
JTRS AMF – Joint Tactical Radio System Airborne & Maritime/Fixed Station	ID	ASD NII and the Joint Staff	Institute for Defense Analyses (IDA) and the Johns Hopkins Applied Physics Lab	FFRDC and University Affiliated Research Center	13	Yes	26
LCS – Littoral Combat Ship	ID	Navy	Naval Surface Warfare Center, Dahlgren	Service	10	No	1
LHA REPLACEMENT – New Amphibious Assault Ship	ID	Navy	Center for Naval Analyses (CNA)	FFRDC	15	No	40
LUH – Light Utility Helicopter	IC	Army	Army's TRADOC Analysis Center (TRAC)	Service	4	No	18
MPS – Mission Planning System	ID	Air Force	Air Force Air Combat Command	Service	14	No	54
MUOS – Mobile User Objective System	ID	Navy	Aerospace Corporation	FFRDC	28	No	30
P-8A – Poseidon Program	ID	Navy	Center for Naval Analyses (CNA)	FFRDC	19	No	28

**Appendix III: Key Characteristics of AOAs**

<b>Program</b>	<b>Acquisition category</b>	<b>Service sponsor</b>	<b>Organization conducting AOA</b>	<b>Type of organization</b>	<b>Length of AOA (in months)</b>	<b>Joint</b>	<b>Months between AOA completion and program start</b>
SDB I – Small Diameter Bomb Increment I	IC	Air Force	Air Combat Command with support from Boeing, Raytheon, Lockheed Martin, and Northrup Grumman	Service contractors	28	Yes	35
VH-71 – Presidential Helicopter Fleet Replacement Program	ID	Navy	Center for Naval Analyses (CNA)	FFRDC	17	No	15
WIN-T – Warfighter Information Network-Tactical	ID	Army	Army's TRADOC Analysis Center (TRAC)	Service	25	No	16 months after MS B

Source: GAO.

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# Appendix IV: GAO Contact and Staff Acknowledgments

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## GAO Contact

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

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## Staff Acknowledgments

In addition to the contact named above, the following individuals made key contributions to this report: John Oppenheim (Assistant Director), Martin G. Campbell, James Kim, John Krump, Claire Li, Guisseli Reyes-Turnell, and Tatiana Winger.

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