

GAO

Report to the Ranking Member,  
Committee on Homeland Security and  
Governmental Affairs, U.S. Senate

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July 2012

# INFORMATION TECHNOLOGY COST ESTIMATION

## Agencies Need to Address Significant Weaknesses in Policies and Practices



G A O

Accountability \* Integrity \* Reliability

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Highlights of [GAO-12-629](#), a report to the Ranking Member, Committee on Homeland Security and Governmental Affairs, U.S. Senate

### Why GAO Did This Study

The federal government plans to spend at least \$75 billion on information technology (IT) investments in fiscal year 2012. The size of this investment highlights the importance of reliably estimating the costs of IT acquisitions. A reliable cost estimate is critical to the success of any IT program, providing the basis for informed decision making and realistic budget formation. Without the ability to generate such estimates, programs risk missing their cost, schedule, and performance targets.

GAO was asked to (1) assess selected federal agencies' implementation of cost-estimating policies and procedures, and (2) evaluate whether selected IT investments at these agencies have reliable cost estimates to support budget and program decisions. To do so, GAO compared policies and procedures to best practices at eight agencies. GAO also reviewed documentation supporting cost estimates for 16 major investments at these eight agencies—representing about \$51.5 billion of the planned IT spending for fiscal year 2012.

### What GAO Recommends

GAO is recommending that the selected agencies modify cost-estimating policies to be consistent with best practices and update future cost estimates of the selected acquisition programs to address identified weaknesses. The seven agencies that commented on a draft of this report generally agreed with GAO's results and recommendations, although the Environmental Protection Agency disagreed with the assessment of one of its investments. However, GAO stands by its assessment.

View [GAO-12-629](#). For more information, contact Valerie C. Melvin at (202) 512-6304 or [melvinv@gao.gov](mailto:melvinv@gao.gov).

## INFORMATION TECHNOLOGY COST ESTIMATION

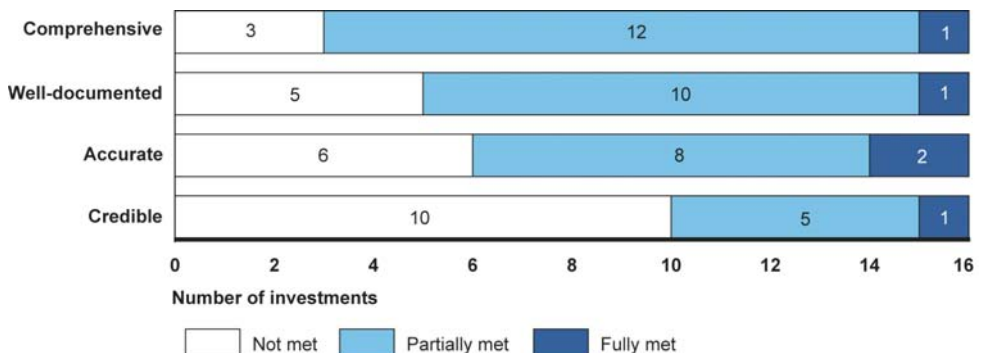
### Agencies Need to Address Significant Weaknesses in Policies and Practices

### What GAO Found

While the eight agencies GAO reviewed—the Departments of Agriculture, Commerce, Defense, Homeland Security, Justice, Labor, and Veterans Affairs, and the Environmental Protection Agency—varied in the extent to which their cost-estimating policies and procedures addressed best practices, most had significant weaknesses. For example, six of the eight agencies had established a clear requirement for programs to develop life-cycle cost estimates. However, most of the eight agencies' policies lacked requirements for cost-estimating training, a standard structure for defining work products, and a central, independent cost-estimating team, among other things. The weaknesses in agencies' policies were due, in part, to the lack of a priority for establishing or enhancing department or agency-level cost-estimating functions. Until agencies address weaknesses in their policies, it will be difficult for them to make effective use of program cost estimates for informed decision making, realistic budget formation, and meaningful progress measurement.

The 16 major acquisition programs had developed cost estimates and were using them, in part, to support program and budget decisions. However, all but 1 of the estimates were not fully reliable—meaning that they did not fully reflect all four characteristics of a reliable cost estimate identified in the GAO cost-estimating guide: comprehensive, well-documented, accurate, and credible (see figure). For example, the estimates for many of these investments did not include all life-cycle costs, such as costs for operating and maintaining the system; did not adequately document the source data and methodologies used to develop the estimate; were not regularly updated so that they accurately reflected current status; and lacked credibility because they were not properly adjusted to account for risks and uncertainty. The inadequate implementation of cost-estimating best practices was largely due to weaknesses in agencies' policies. Until cost-estimating best practices are fully implemented, these programs face an increased risk that managers will not be able to effectively use their cost estimates as a sound basis for informed program and budget decision making.

Assessment of Cost-Estimating Practices for Case Study Programs



Source: GAO analysis of agency data.

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## Abbreviations

BA	Benefit Administration
CANES	Consolidated Afloat Networks and Enterprise Services
CLASS	Comprehensive Large Array-data Stewardship System
CODIS	Combined DNA Index System
DOD	Department of Defense
EPA	Environmental Protection Agency
HDR	Health Data Repository
IPAWS	Integrated Public Alert and Warning System
IT	information technology
FSMP	Financial System Modernization Project
NGCODIS	Next Generation Combined DNA Index System
TMC	Tactical Mission Command
OMB	Office of Management and Budget
OIS	OSHA Information System
OSHA	Occupational Safety and Health Administration
PBGC	Pension Benefit Guaranty Corporation
PE2E-SE	Patents End-to-End: Software Engineering
PHIS	Public Health Information System
SEMS	Superfund Enterprise Management System
UFMS	Unified Financial Management System
VBMS	Veterans Benefits Management System
WBSCM	Web-Based Supply Chain Management

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United States Government Accountability Office  
Washington, DC 20548

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July 11, 2012

The Honorable Susan M. Collins  
Ranking Member  
Committee on Homeland Security  
and Governmental Affairs  
United States Senate

Dear Senator Collins:

In fiscal year 2012, the federal government plans to spend at least \$75 billion on information technology (IT) investments, many of which involve systems and technologies to modernize legacy systems, increase communication and networking capabilities, and transition to new systems designed to significantly improve the government's ability to carry out critical mission functions in the 21st century.<sup>1</sup> Given the size of this investment, it is important that IT acquisitions are based on reliable estimates of costs over their full acquisition life cycles. The ability to generate a reliable cost estimate is critical to the success of any IT program, as it provides the basis for informed decision making, realistic budget formulation, and meaningful progress measurement. Without this ability, programs are at risk of experiencing cost overruns, missed deadlines, and performance shortfalls.

This report responds to your request that we evaluate the implementation of cost-estimating processes at selected federal government departments and agencies. Specifically, our objectives were to (1) assess the extent to which selected departments and agencies have appropriately implemented cost-estimating policies and procedures, and (2) evaluate whether selected IT investments at these departments and agencies have reliable cost estimates to support budget and program decisions.

To assess the extent to which selected departments and agencies have appropriately implemented cost-estimating policies and procedures, we

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<sup>1</sup>Office of Management and Budget, *Report on IT Spending for the Federal Government*, February 2012.

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reviewed cost-estimating policies and procedures from eight agencies.<sup>2</sup> The eight agencies were selected from across different ranges of planned IT spending in fiscal year 2010.<sup>3</sup> The number of agencies selected from each range was based on the relative number of IT investments within each range, and the specific agencies selected were those with the highest amount of planned IT spending in fiscal year 2010. Specifically, we chose one agency with greater than \$10 billion in planned IT spending,<sup>4</sup> five agencies with between \$1 billion and \$10 billion in planned spending, and two agencies with less than \$1 billion in planned spending. We compared the agencies' policies and procedures with the best practices identified in GAO's cost-estimating guide<sup>5</sup> to determine the comprehensiveness of each agency's established policies for cost estimating. For each policy component, we assessed it as either being not met—the agency did not provide evidence that it addressed the policy component or provided evidence that it minimally addressed the policy component; partially met—the agency provided evidence that it addressed about half or a large portion of the policy component; or fully met—the agency provided evidence that it fully addressed the policy component. In addition, we interviewed relevant agency officials, including officials responsible for developing cost-estimating policies.

To evaluate whether selected IT investments at these departments and agencies have reliable cost estimates to support budget and program decisions, we reviewed individual programs' relevant cost-estimating documentation, including, for example, the current life-cycle cost estimate and schedule and technical baseline information, from 16 major

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<sup>2</sup>The eight agencies were the Departments of Agriculture, Commerce, Defense, Homeland Security, Justice, Labor, and Veterans Affairs, and the Environmental Protection Agency. We did not review the cost-estimating policies at these agencies' components or smaller agencies.

<sup>3</sup>We relied on the Office of Management and Budget Fiscal Year 2010 Exhibit 53, which contained data on the planned IT spending at 28 agencies, to select the 8 agencies for review. At the time the 8 agencies were selected, the Office of Management and Budget Fiscal Year 2010 Exhibit 53 was the most current source with complete data on agencies' planned IT spending.

<sup>4</sup>Only one agency, the Department of Defense, had greater than \$10 billion in IT spending in fiscal year 2010.

<sup>5</sup>GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: March 2009).

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investments at the eight agencies.<sup>6</sup> The 16 programs selected for case study (2 per agency) were among the largest in terms of planned spending; considered major IT investments<sup>7</sup>; and had a higher percentage of development versus steady-state<sup>8</sup> spending, among other things. We compared the programs' life-cycle cost estimates and underlying support with the best practices identified in GAO's cost-estimating guide<sup>9</sup> to determine the extent to which the estimates are reliable and are being used to support budget and program decisions. Specifically, we assessed program practices against the four characteristics of a reliable estimate—comprehensive, well-documented, accurate, and credible. For each characteristic, we assessed multiple practices as being not met—the program did not provide evidence that it implemented the practices or provided evidence that it only minimally implemented the practices; partially met—the program provided evidence that it implemented about half or a large portion of the practices; or fully met—the program provided evidence that it fully implemented the practices. We then summarized these assessments by characteristic. In addition, we interviewed relevant agency officials, including key personnel on the programs that we selected for case study.

We conducted this performance audit from July 2011 through July 2012, in accordance with generally accepted government auditing standards.

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<sup>6</sup>One investment selected from the Department of Labor is the responsibility of the Pension Benefit Guaranty Corporation (PBGC). PBGC is a wholly owned government corporation administered by a presidentially appointed, Senate-confirmed Director and overseen by a Board of Directors consisting of the Secretaries of Labor, the Treasury, and Commerce. Although not a component of the Department of Labor, for administrative purposes, PBGC is included within the department's budget submission documentation. Therefore, PBGC's IT investments were included among the Department of Labor's IT investments in the Office of Management and Budget Fiscal Year 2010 Exhibit 53, which provided the basis for our selection of the 16 case study programs.

<sup>7</sup>The Office of Management and Budget defines a major IT investment as a system or an acquisition requiring special management attention because it has significant importance to the mission or function of the agency, a component of the agency, or another organization; is for financial management and obligates more than \$500,000 annually; has significant program or policy implications; has high executive visibility; has high development, operating, or maintenance costs; is funded through other than direct appropriations; or is defined as major by the agency's capital planning and investment control process.

<sup>8</sup>Steady state refers to operating and maintaining systems at current levels (i.e., without major enhancements).

<sup>9</sup>[GAO-09-3SP](#).



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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 I contains further details about our objectives, scope, and methodology.

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## Background

Given the size and significance of the government's investment in IT, it is important that projects be managed effectively to ensure that public resources are wisely invested. Effectively managing projects entails, among other things, developing reliable and high-quality cost estimates that project realistic life-cycle costs. A life-cycle cost estimate provides an exhaustive and structured accounting of all resources and associated cost elements required to develop, produce, deploy, and sustain a particular program. In essence, life cycle can be thought of as a "cradle to grave" approach to managing a program throughout its useful life. Because a life-cycle cost estimate encompasses all past (or sunk), present, and future costs for every aspect of the program, regardless of funding source, it provides a wealth of information about how much programs are expected to cost over time.

We have previously reported<sup>10</sup> that a reliable cost estimate is critical to the success of any government acquisition program, as it provides the basis for informed investment decision making, realistic budget formulation and program resourcing, meaningful progress measurement, proactive course correction, and accountability for results. Having a realistic, up-to-date estimate of projected costs—one that is continually revised as the program matures—can be used to support key program decisions and milestone reviews. In addition, the estimate is often used to determine the program's budget spending plan, which outlines how and at what rate the program funding will be spent over time. Because a reasonable and supportable budget is essential to a program's efficient and timely execution, a reliable estimate is the foundation of a good

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<sup>10</sup>See for example, GAO, *Defense Infrastructure: Navy Can Improve the Quality of Its Cost Estimate to Homeport an Aircraft Carrier at Naval Station Mayport*, [GAO-11-309](#) (Washington, D.C.: Mar. 3, 2011); *Secure Border Initiative: DHS Needs to Reconsider Its Proposed Investment in Key Technology Program*, [GAO-10-340](#) (Washington, D.C.: May 5, 2010); and *DOD Business Systems Modernization: Key Marine Corps System Acquisition Needs to Be Better Justified, Defined, and Managed*, [GAO-08-822](#) (Washington, D.C.: July 28, 2008).

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budget. However, we have also found that developing reliable cost estimates has been difficult for agencies across the federal government.<sup>11</sup> Too often, programs cost more than expected and deliver results that do not satisfy all requirements.

In 2006, the Office of Management and Budget (OMB) updated its *Capital Programming Guide*, which requires agencies to develop a disciplined cost-estimating capability to provide greater information management support, more accurate and timely cost estimates, and improved risk assessments to help increase the credibility of program cost estimates.<sup>12</sup> Further, according to OMB, programs must maintain current and well-documented estimates of costs, and these estimates must encompass the full life cycle of the program. Among other things, OMB states that generating reliable cost estimates is a critical function necessary to support OMB's capital programming process. Without this ability, programs are at risk of experiencing cost overruns, missed deadlines, and performance shortfalls.

Building on OMB's requirements, in March 2009, we issued a guide on best practices for estimating and managing program costs that highlights the policies and practices adopted by leading organizations to implement an effective cost-estimating capability.<sup>13</sup> Specifically, these best practices

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<sup>11</sup>See for example, GAO, *IRS Management: Cost Estimate for New Information Reporting System Needs to be Made More Reliable*, [GAO-12-59](#) (Washington, D.C.: Jan. 31, 2012); *Information Technology: Better Informed Decision Making Needed on Navy's Next Generation Enterprise Network Acquisition*, [GAO-11-150](#) (Washington, D.C.: Mar. 11, 2011); *Department of Energy: Actions Needed to Develop High-Quality Cost Estimates for Construction and Environmental Cleanup Projects*, [GAO-10-199](#) (Washington, D.C.: Jan. 14, 2010); *VA Construction: VA Is Working to Improve Initial Project Cost Estimates, but Should Analyze Cost and Schedule Risks*, [GAO-10-189](#) (Washington, D.C.: Dec. 14, 2009); *DOD Business Systems Modernization: Planned Investment in Navy Program to Create Cashless Shipboard Environment Needs to Be Justified and Better Managed*, [GAO-08-922](#) (Washington, D.C.: Sept. 8, 2008); and *2010 Census: Census Bureau Should Take Action to Improve the Credibility and Accuracy of Its Cost Estimate for the Decennial Census*, [GAO-08-554](#) (Washington, D.C.: June 16, 2008).

<sup>12</sup>OMB, *Circular No. A-11, Preparation, Submission, and Execution of the Budget* (Washington, D.C.: Executive Office of the President, June 2006) and *Capital Programming Guide: Supplement to Circular A-11, Part 7, Planning, Budgeting, and Acquisition of Capital Assets* (Washington, D.C.: Executive Office of the President, June 2006). OMB first issued the *Capital Programming Guide* as a supplement to the 1997 version of Circular A-11, Part 3. We refer to the 2006 version. OMB later updated this guide again in August 2011.

<sup>13</sup>[GAO-09-3SP](#).

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identify the need for organizational policies that define a clear requirement for cost estimating; require compliance with cost-estimating best practices; require management review and acceptance of program cost estimates; provide for specialized training; establish a central, independent cost-estimating team; require a standard structure for defining work products; and establish a process to collect and store cost-related data. In addition, the cost-estimating guide identifies four characteristics of a reliable cost estimate that management can use for making informed program and budget decisions: a reliable cost estimate is comprehensive, well-documented, accurate, and credible. Specifically, an estimate is

- *comprehensive* when it accounts for all possible costs associated with a program, is structured in sufficient detail to ensure that costs are neither omitted nor double counted, and documents all cost-influencing assumptions;
- *well-documented* when supporting documentation explains the process, sources, and methods used to create the estimate, contains the underlying data used to develop the estimate, and is adequately reviewed and approved by management;
- *accurate* when it is not overly conservative or optimistic, is based on an assessment of the costs most likely to be incurred, and is regularly updated so that it always reflects the current status of the program; and
- *credible* when any limitations of the analysis because of uncertainty or sensitivity surrounding data or assumptions are discussed, the estimate's results are cross-checked, and an independent cost estimate is conducted by a group outside the acquiring organization to determine whether other estimating methods produce similar results.

We have previously reported on weaknesses associated with the implementation of sound cost-estimating practices at various agencies and the impact on budget and program decisions. For example,

- In January 2012, we reported that the Internal Revenue Service did not have comprehensive guidance for cost estimating.<sup>14</sup> Specifically,

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<sup>14</sup>[GAO-12-59](#).

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the agency's guidance did not clearly discuss the appropriate uses of different types of cost estimates. Further, our review of the agency's Information Reporting and Document Matching program's cost estimate found it was unreliable. Among other things, the program's projected budget of \$115 million through fiscal year 2016 was only partly supported by the cost estimate, which included costs only through fiscal year 2014. As a result, the agency did not have a reliable basis for the program's budget projection. We made multiple recommendations to improve the quality of the agency's cost and budget information, including ensuring that the Information Reporting and Document Matching program's cost estimate is reliable and that the agency's cost-estimating guidance is consistent and clearly requires the use of current and reliable cost estimates to inform budget requests. The agency partially agreed with these recommendations and stated that they have taken steps to ensure that their cost-estimating practices and procedures follow consistent documented guidance.

- In January 2010, we reported that the Department of Energy lacked comprehensive policy for cost estimating, making it difficult for the agency to oversee development of high-quality cost estimates.<sup>15</sup> Specifically, the agency's policy did not describe how estimates should be developed and did not establish a central office for cost estimating. Further, we reviewed four programs at the department, each estimated to cost approximately \$900 million or more, and reported that they did not have reliable cost estimates. For example, three of the cost estimates did not include costs for the full life cycles of the programs, omitting operations and maintenance costs or portions of program scope. Additionally, three of the cost estimates did not use adequate data, one of which relied instead on professional opinion. Further, the cost estimates did not fully incorporate risk—specifically, they did not address correlated risks among project activities. As a result, these programs were more likely to exceed their estimates and require additional funding to be completed. We made multiple recommendations to improve cost estimating at the department, including updating its cost-estimating policy and guidance and ensuring cost estimates are developed in accordance with best practices. The Department of Energy generally agreed with our recommendations and stated that it had several initiatives underway

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<sup>15</sup>[GAO-10-199](#).

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to improve cost-estimating practices, including the development of a new cost-estimating policy and guidance, a historical cost database to support future estimates, and additional training courses.

- Finally, we reported in December 2009 that the Department of Veterans Affairs had 18 construction projects that had experienced cost increases due, in part, to unreliable cost estimates.<sup>16</sup> For example, many estimates were completed quickly, one of which was a rough-order-of-magnitude estimate that was not intended to be relied on as a budget-quality estimate of full project costs. Additionally, we found that some projects had not conducted a risk analysis to quantify the impact of risk on the total estimated costs. As a result, in some cases, projects had to change scope to meet their initial estimate and, in others, additional funds had to be requested from Congress to allow the agency to complete the project. We recommended that the department improve cost estimating at major construction projects by conducting cost risk analyses and mitigating risks that may influence projects' costs. The Department of Veterans Affairs agreed with our recommendation and stated that it was taking steps, such as developing a multiyear construction plan to ensure that reliable projections of program costs are available for budgeting purposes, and planning to improve its risk analyses.

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## Selected Agencies' Cost-Estimating Policies and Procedures Have Significant Weaknesses

According to OMB,<sup>17</sup> agencies should develop a disciplined cost-estimating capability to provide greater information management support, more accurate and timely cost estimates, and improved risk assessments to help increase the credibility of program cost estimates. In addition, we have reported<sup>18</sup> that leading organizations establish cost-estimating policies and procedures that

- define a clear requirement for cost estimating;

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<sup>16</sup>[GAO-10-189](#).

<sup>17</sup>OMB, *Capital Programming Guide, v.3.0, Supplement to OMB Circular A-11: Planning, Budgeting, and Acquisition of Capital Assets* (Executive Office of the President, Washington, D.C.: August 2011).

<sup>18</sup>[GAO-09-3SP](#).

- identify and require compliance with cost-estimating best practices, and validate their use;
- require that estimates be reviewed and approved by management;
- require and enforce training in cost estimating;
- establish a central, independent cost-estimating team;
- require, at a high level, a standard, product-oriented work breakdown structure; and
- establish a process for collecting and storing cost-related data to support future estimates.

Table 1 describes the key components of an effective cost-estimating policy.

**Table 1: Key Components of an Effective Cost-Estimating Policy**

Component	Description
Clear requirement for cost estimating	A clear requirement should be established for cost estimating, especially for all major investments. Specifically, agencies should clearly require every program to develop a cost estimate that accounts for the full program life cycle. Further, if agencies choose to specify more or less detail and review for different investments, they should clearly identify, document, and disseminate thresholds differentiating investments based on their size or strategic importance. In particular, major investments require special management attention. A program life-cycle cost estimate can increase the probability of a program's success by supporting effective program and budget decision making, as cost estimates are necessary to support decisions about funding one program over another, develop budget requests, develop performance measurement baselines, and support effective resource allocation.
Compliance with cost-estimating best practices	The use of cost-estimating best practices, such as those outlined in the GAO cost guide, should be identified, required, and validated. These practices include, among other things, gathering cost data, conducting a risk and uncertainty analysis, and updating the estimate. Identifying and requiring the use of best practices when developing cost estimates should result in estimates that are defensible, consistent, and trustworthy. It is also important that cost estimators and organizations independent of the program office validate that program cost estimates are reliable, including assessing whether the estimates were developed in accordance with best practices.
Management review and approval	The policy should require that cost estimates be reviewed and approved by management, and define certain aspects of this process. To facilitate presenting estimates to management, the entity to whom the estimates will be presented and the general format of the information provided should be identified. Examples of information typically provided with an estimate include, among other things, the quality and reliability of the technical baseline and data used, what level of confidence the estimate represents after all risks have been quantified, and the amount of contingency reserve needed to increase the estimate's confidence to an acceptable level. Lastly, management's approval of the estimate should be documented.

Component	Description
Training requirements	Training in cost estimating should be required and enforced for personnel with program management and investment oversight responsibilities. Additionally, when government managers rely on contractors to develop cost estimates, special care must be taken to ensure that the government staff have enough training and experience to determine whether the cost estimate conforms to best practices.
Central, independent cost-estimating team	The cost-estimating team and process should be centralized independent of program offices. Regardless of agency size, this facilitates the use of standardized processes, the identification of resident experts, a better sharing of resources, and commonality and consistency of tools and training.
Standard structure for defining work products	A standard, product-oriented work breakdown structure should be established, at a high level. Such a structure deconstructs a program's end product into successive levels with smaller specific elements until the work is subdivided to a level suitable for management control. This ensures the use of high-quality estimating structures that allow programs to plan and track cost and schedule by defined deliverables, and results in more consistent cost estimates. It also enables the agency to compare costs across programs, as not standardizing the work breakdown structure causes extreme difficulty in comparing costs from one contractor or program to another. Additionally, standardizing the work breakdown structure enables an organization to collect and share data among programs.
Process to collect and store cost-related data	A process should be established to collect and store complete actual cost-related data from past estimates. This ensures that data are available to support future estimates by making data available in retrievable cost databases, which is essential because cost estimating requires current and relevant cost data to remain credible. Additionally, to ensure the data can be used reliably for future estimates, the data collection effort needs to include schedule and technical data to allow future cost estimators to understand the history behind the data.

Source: GAO-09-3SP.

While the eight agencies varied in the extent to which their cost-estimating policies and procedures addressed best practices, most did not address several key components of an effective policy. Specifically, only the Department of Defense's (DOD) policy was fully consistent with all seven components. While the Department of Homeland Security addressed most components of an effective cost-estimating policy, other agencies' policies had significant weaknesses, particularly in cost-estimating training and in establishing a process to collect and store cost-related data.

Table 2 provides a detailed assessment of each agency's policies against the components of an effective cost-estimating policy. In addition, a discussion of each policy component follows the table.

**Table 2: Assessment of Selected Agencies' Cost-Estimating Policies**

Agency	Clear requirement for cost estimating	Compliance with cost-estimating best practices	Management review and approval	Training requirements	Central, independent cost-estimating team	Standard structure for defining work products	Process to collect and store cost-related data
Agriculture	●	◐	◐	○	○	○	○
Commerce	◐	○	○	○	○	○	○
Defense	●	●	●	●	●	●	●
Environmental Protection Agency	●	◐	◐	○	○	○	○
Homeland Security	●	●	●	◐	●	◐	○
Justice	●	◐	○	○	○	◐	○
Labor	●	●	●	◐	○	○	○
Veterans Affairs	◐	○	◐	○	●	◐	○

**Key**

- =Fully met—the agency provided evidence that it fully addressed the policy component.
- ◐=Partially met—the agency provided evidence that it addressed about half or a large portion of the policy component.
- =Not met—the agency did not provide evidence that it addressed the policy component or provided evidence that it minimally addressed the policy component.

Source: GAO analysis of agency data.

- *Clear requirement for cost estimating:* Six of the eight agencies fully addressed this policy component by establishing a clear requirement for all programs to perform life-cycle cost estimates, and in certain cases specified more stringent requirements for programs designated as major investments. Among these, four agencies—the Department of Agriculture, the Environmental Protection Agency (EPA), the Department of Labor, and the Department of Justice—established this requirement as part of their policies for programs to perform a cost-benefit analysis. For example, Labor required a life-cycle cost estimate as part of a cost-benefit analysis for both major and nonmajor investments, with less detail required for nonmajor investments. The other two agencies—DOD and Homeland Security—defined a separate requirement for programs to develop life-cycle cost estimates. For the two agencies that did not fully establish a clear requirement for cost estimating, the Department of Veterans Affairs partially addressed this component because its policy only requires cost estimates to be prepared for project increments, rather than the full program life cycle. In addition, the Department of Commerce partially addressed this component because its policies



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only require cost estimates to be prepared for contracts, rather than for the full program life cycle (including government and contractor costs). Officials at both agencies stated that the responsibility for establishing requirements for cost estimating had been delegated to their component agencies. Further, officials at these two agencies described steps planned to address this and other weaknesses. For example, Veterans Affairs officials stated that the agency's recently established Office of Corporate Analysis and Evaluation (part of the Office of Planning and Policy) is planning to establish a centralized cost-estimating policy that includes clear criteria for cost estimating, which it expects to complete in fiscal year 2012. Further, Commerce officials stated that the agency is currently in the process of updating its policy and guidance to address this and other weaknesses, which it plans to complete by October 2012. If the updated policies and guidance address the weaknesses we identified, decision makers should have an improved view of their programs' life-cycle costs.

- *Compliance with cost-estimating best practices:* Three of the eight agencies (DOD, Homeland Security, and Labor) fully addressed this policy component by identifying and requiring the use of cost-estimating best practices by their programs, and defining a process to validate their use. For example, Homeland Security draws on the GAO cost guide<sup>19</sup> to identify cost-estimating best practices, and also provides agency-specific cost-estimating requirements for implementing the practices, such as identifying the cost-estimate documentation required. The agency's policy also requires that estimates for key programs be validated. For the three agencies that partially addressed this policy component—Agriculture, EPA, and Justice—all provided guidance to their programs specific to conducting a cost-benefit analysis; however, this guidance did not fully address important cost-estimating practices, such as conducting a risk and uncertainty analysis, updating the estimate, or comparing the estimate to an independent estimate. Their guidance also did not identify a mechanism for validating estimates. Lastly, two agencies—Commerce and Veterans Affairs—had not addressed this policy component, which corresponds to our finding that these agencies did not have requirements for programs to prepare cost estimates. Among the five agencies that did not fully address this policy component, officials commonly stated that the responsibility for

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<sup>19</sup>[GAO-09-3SP](#).

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requiring compliance with best practices had been delegated to their component agencies or that addressing cost-estimating shortcomings had not been a priority. Without fully complying with best practices for developing cost estimates, programs are less likely to prepare reliable cost estimates, hindering agency decision making.

- *Management review and approval:* Three of the eight agencies (DOD, Homeland Security, and Labor) fully addressed this policy component by requiring that program cost estimates be reviewed and approved by management, including defining the information to be presented and requiring that approval be documented. For example, Labor's policy requires that senior management at both the component agency responsible for the program and the Office of the Chief Information Officer approve the estimate, based on a briefing that includes information about the estimate such as the largest cost drivers, major risks, and the findings of the integrated baseline review,<sup>20</sup> and that this approval is documented. For the three agencies that partially addressed this policy component (Agriculture, EPA, and Veterans Affairs), all required that estimated costs be presented to management, but none fully defined the information to be presented, such as the confidence level associated with the estimate. Lastly, neither Justice nor Commerce had departmental requirements for management review and approval of the cost estimate. Officials at both agencies stated that this responsibility had been delegated to their component agencies. However, without requiring management review and approval of program cost estimates at the department level, agencies have reduced ability to enforce cost-estimating policies and ensure that cost estimates meet management's needs for reliable information about programs' estimated costs.
- *Training requirements:* Only one agency—DOD—fully addressed this policy component by requiring cost-estimating training and enforcing this requirement. For example, DOD requires training in cost

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<sup>20</sup>An integrated baseline review is an evaluation of a program's baseline plan to determine whether all program requirements have been addressed, risks have been identified, mitigation plans are in place, and available and planned resources are sufficient to complete the work.

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estimating via its Defense Acquisition Workforce Improvement Act<sup>21</sup> certifications, among other things, for at least one staff member for each major program, as well as for personnel with investment oversight responsibility. While the two agencies that partially addressed this policy component (Homeland Security and Labor) provided cost-estimating training and had a mechanism to track participation, their policies did not address providing training to personnel with investment oversight responsibility, such as officials from Homeland Security who are responsible for reviewing and approving programs at key milestones in their life cycles. Among the five agencies whose policies did not address requiring and enforcing training in cost estimating (Agriculture, Commerce, EPA, Justice, and Veterans Affairs), four of these agencies referred to OMB's Federal Acquisition Certification for Program and Project Managers<sup>22</sup> as providing for such training. However, this certification program does not require classes on cost estimating, and furthermore, is not intended for nor provided to individuals with investment oversight responsibility. Additionally, officials at two of the five agencies—Commerce and Veterans Affairs—stated that training in cost estimating had not been viewed as a priority. Without requiring and enforcing training in cost estimating, agencies cannot effectively ensure that staff have the skills and knowledge necessary to prepare and use cost estimates to make reliable budget and program decisions.

- *Central, independent cost-estimating team:* Three of the eight agencies (DOD, Homeland Security, and Veterans Affairs) fully addressed this policy component by establishing central, independent cost-estimating teams, all of which have responsibility for, among other things, developing cost-estimating guidance and validating that program cost estimates are developed in accordance with best practices.<sup>23</sup> In addition, among these three agencies, the teams

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<sup>21</sup>The Defense Acquisition Workforce Improvement Act, 10 U.S.C. §§ 1701-1764. This act recognized acquisition as a multidisciplinary career field for DOD, which now identifies 16 career fields/paths, of which one is cost estimating and financial management.

<sup>22</sup>OMB established the Federal Acquisition Certification for Program and Project Managers program in 2007 to support skill development of program and project managers. The program applies to all civilian agencies.

<sup>23</sup>GAO has ongoing work to assess DOD's cost-estimating office (known as Cost Assessment and Program Evaluation), including the implementation of its responsibilities under the Weapon Systems Acquisition Reform Act of 2009 (10 U.S.C. § 2334).

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established at DOD and Veterans Affairs are also charged with improving cost-estimating training. The remaining five agencies had not established a central, independent cost-estimating team. Among these, officials commonly cited the lack of a priority at the department or agency level for cost-estimating initiatives, although in one case a component agency at Agriculture—the Food Safety and Inspection Service—established its own centralized cost-estimating team. While this will likely enhance cost estimating at the component agency, not centralizing the cost-estimating function in the department could result in ad hoc processes and a lack of commonality in the estimating tools and training across the department. Additionally, officials from Labor stated they believe the department’s IT budget is too small to cost-effectively centralize the cost-estimating function; however, doing so would likely, among other things, facilitate a better sharing of resources and could be accomplished in a manner commensurate with agency size. Agencies that do not establish a central and independent cost-estimating team may lack the ability to improve the implementation of cost-estimating policies, support cost-estimating training, and validate the reliability of program cost estimates at the department or agency level.

- *Standard structure for defining work products:* DOD was the only agency to fully address this policy component by developing and requiring the use of standard, product-oriented work breakdown structures. Specifically, the agency provided multiple standard work breakdown structures, along with detailed guidance, for different types of programs (e.g., automated information systems, space systems, aircraft systems), and required their use. Three agencies—Homeland Security, Justice, and Veterans Affairs—partially addressed this policy component in that they provided one or more product-oriented work breakdown structures in their policies, but did not require programs to use them for cost estimating. Among these, Justice officials stated that a standard work breakdown structure was only required for their earned value management<sup>24</sup> processes. Further, both Veterans Affairs and Homeland Security stated that they intend to require the use of a standard work breakdown structure in the future, but had not yet determined a time frame for establishing this requirement. Lastly,

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<sup>24</sup>Earned value management is a project management tool that integrates the technical scope of work with schedule and cost elements for investment planning and control. It compares the value of work accomplished in a given period with the value of the work expected in that period.

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four of the selected agencies—Agriculture, Commerce, EPA, and Labor—had not established a standard structure. Among these, officials from Agriculture, EPA, and Labor stated that they believe it is difficult to standardize how programs define work products, in part, because their programs conduct different types of work and have different needs. While this presents a challenge, agencies could adopt an approach similar to DOD's and develop various standard work structures based on the kinds of work being performed. Commerce officials stated that they plan to establish a standard structure for defining work products in the future, but have not yet determined a time frame for completing this. Without establishing a standard structure for defining work products, agencies will not be positioned to ensure that they can effectively compare programs and collect and share data among programs.

- *Process to collect and store cost-related data:* Only one agency—DOD—fully addressed this policy component by establishing a process to collect and store cost-related data. Specifically, the agency has a central repository for collecting actual costs, software data, and related business data, which serves as a resource to support cost estimating across the agency. Among the seven agencies that have not established a process for collecting and storing cost-related data, Homeland Security's policy assigns responsibility for doing so to the central cost-estimating team; however, the team has not yet implemented the process. Additionally, Veterans Affairs officials stated that collecting such data would depend on the use of a standard structure for defining work products, which they have not yet put in place. Agriculture and Commerce officials stated that cost-estimating initiatives have not been a priority, although in one case a component agency at Commerce—the United States Patent and Trademark Office—took the initiative to establish a process to collect and store cost-related data from past estimates. While this should improve cost estimating at the component agency, without establishing an agencywide process to collect and store cost-related data, agencies will find it difficult to improve the data available to all programs and to increase the efficiency of developing cost estimates.

Until the selected agencies address the identified weaknesses in their cost-estimating policies, it will be difficult for them to make effective use of program cost estimates for informed decision making, realistic budget formation, and meaningful progress measurement.

## Selected Agencies' Program Cost Estimates Do Not Provide a Fully Reliable Basis for Program and Budget Decisions

A reliable cost estimate is critical to the success of any government acquisition program, as it provides the basis for informed investment decision making, realistic budget formulation and program resourcing, and meaningful progress measurement. According to OMB,<sup>25</sup> programs must maintain current and well-documented cost estimates, and these estimates must encompass the full life cycle of the programs. In addition, our research has identified a number of best practices that provide a basis for effective program cost estimating and should result in reliable cost estimates that management can use for making informed decisions. These practices can be organized into four characteristics—comprehensive, well-documented, accurate, and credible. These four characteristics of a reliable cost estimate are explained in table 3.

**Table 3: Four Characteristics of a Reliable Cost Estimate**

Characteristic	Explanation
Comprehensive	The cost estimate should include both government and contractor costs of the program over its full life cycle, from inception of the program through design, development, deployment, and operation and maintenance, to retirement of the program. It should also completely define the program, reflect the current schedule, and be technically reasonable. Comprehensive cost estimates should be structured in sufficient detail (at least three levels of cost elements) to ensure that costs are neither omitted nor double counted. <sup>a</sup> Specifically, the cost estimate should be based on a product-oriented work breakdown structure that allows a program to track cost and schedule by defined deliverables, such as hardware or software components. Finally, where information is limited and judgments must be made, the cost estimate should document all cost-influencing ground rules and assumptions.
Well-documented	A good cost estimate—while taking the form of a single number—is supported by detailed documentation that describes how it was derived and how the expected funding will be spent in order to achieve a given objective. Therefore, the documentation should capture in writing such things as the source data used, the calculations performed and their results, and the estimating methodology used to derive each work breakdown structure element's cost. Moreover, this information should be captured in such a way that the data used to derive the estimate can be traced back to and verified against their sources so that the estimate can be easily replicated and updated. The documentation should also discuss the technical baseline description and how the data were normalized. Finally, the final cost estimate should be reviewed and accepted by management on the basis of confidence in the estimating process and the estimate produced by the process.
Accurate	The cost estimate should provide for results that are unbiased, and it should not be overly conservative or optimistic. An estimate is accurate when it is based on an assessment of most likely costs, adjusted properly for inflation, and contains few, if any, minor mistakes. In addition, the estimate should be grounded in a historical record of cost estimating and actual experiences on other comparable programs. Finally, a cost estimate should be updated regularly to reflect material changes in the program, such as when schedules or other assumptions change, and actual costs, so that it is always reflecting current status.

<sup>25</sup>OMB, *Circular No. A-11, Preparation, Submission, and Execution of the Budget and Capital Programming Guide, v.3.0, Supplement to OMB Circular A-11: Planning, Budgeting, and Acquisition of Capital Assets.*

Characteristic	Explanation
Credible	<p>The cost estimates should discuss any limitations of the analysis because of uncertainty or biases surrounding data or assumptions. Major assumptions should be varied, and other outcomes recomputed to determine how sensitive they are to changes in the assumptions (i.e., sensitivity analysis). A risk and uncertainty analysis should be performed to determine the level of risk associated with the estimate. For management to make good decisions, the program estimate must reflect the degree of uncertainty, so that a level of confidence can be given about the estimate. Having a range of costs around a point estimate is more useful to decision makers because it conveys the level of confidence in achieving the most likely cost and also informs them on cost, schedule, and technical risks.<sup>b</sup> Further, the estimate's results should be cross-checked, and an independent cost estimate conducted by a group outside the acquiring organization should be developed to determine whether other estimating methods produce similar results.</p>

Source: GAO-09-3SP.

<sup>a</sup>The appropriate number of levels for a work breakdown structure varies from program to program and depends on a program's complexity and risk. However, each work breakdown structure should, at the very least, include three levels. The first level represents the program as a whole and therefore contains only one element—the program's name. The second level contains the major program segments, and level three contains the lower-level components or subsystems for each segment.

<sup>b</sup>A point estimate is the most likely value for the cost estimate, given the underlying data. The level of confidence for the point estimate is the probability that the point estimate will actually be met. For example, if the confidence level for a point estimate is 80 percent, there is an 80 percent chance that the final cost will be at or below the point estimate and a 20 percent chance that costs will exceed the point estimate.

### Nearly All Programs Did Not Fully Meet the Characteristics of a Reliable Cost Estimate

While all 16 major acquisition programs we reviewed had developed cost estimates and were using them to inform decision making, all but one of the estimates were not fully reliable and did not provide a sound basis for informed program and budget decisions. The 16 acquisition programs had developed cost estimates and were using their estimates, in part, to support program and budget decisions. For example, most programs used their cost estimate as the basis for key program decisions, such as approval to proceed to full production of a system. In addition, most programs were using their estimates as an input to their annual budget request process.

However, nearly all of these programs had estimates that did not fully reflect important cost-estimating practices. Specifically, of the 16 case study programs, only 1 fully met all four characteristics of a reliable cost estimate, while the remaining 15 programs varied in the extent to which they met the four characteristics. Table 4 identifies the 16 case study programs and summarizes our results for these programs. Following the table is a summary of the programs' implementation of cost-estimating practices. Additional details on the 16 case studies are provided in appendix II.

**Table 4: Assessment of Cost-Estimating Practices for Case Study Programs**

Agency	Program	Comprehensive	Well-documented	Accurate	Credible
Agriculture	Public Health Information System	●	○	○	○
	Web-Based Supply Chain Management	○	○	○	○
Commerce	Comprehensive Large Array-data Stewardship System	●	○	○	○
	Patents End-to-End: Software Engineering	●	●	●	○
Defense	Tactical Mission Command	●	●	●	○
	Consolidated Afloat Networks and Enterprise Services	●	●	●	●
Environmental Protection Agency	Financial System Modernization Project	●	●	●	○
	Superfund Enterprise Management System	○	○	○	●
Homeland Security	Integrated Public Alert and Warning System	●	●	●	●
	Rescue 21	●	●	●	●
Justice	Unified Financial Management System	●	●	●	○
	Next Generation Combined DNA Index System	●	●	●	●
Labor	OSHA <sup>a</sup> Information System	●	●	●	○
	PBGC <sup>b</sup> Benefit Administration	●	●	●	●
Veterans Affairs	Health Data Repository	○	○	○	○
	Veterans Benefits Management System	●	●	○	○

**Key**

●=Fully met—the program provided evidence that it fully implemented the cost-estimating practices for this characteristic.

●=Partially met—the program provided evidence that it implemented about half or a large portion of the cost-estimating practices for this characteristic.

○=Not met—the program did not provide evidence that it implemented the practices or provided evidence that it only minimally implemented the cost-estimating practices for this characteristic.

Source: GAO analysis of program data.

<sup>a</sup>Occupational Safety and Health Administration.

<sup>b</sup>Pension Benefit Guaranty Corporation. PBGC is a wholly owned government corporation administered by a presidentially appointed, Senate-confirmed Director and overseen by a Board of Directors consisting of the Secretaries of Labor, the Treasury, and Commerce. Although not a component of the Department of Labor, for administrative purposes, PBGC is included within the department’s budget submission documentation. Therefore, PBGC’s IT investments (including Benefit Administration) were included among the Department of Labor’s IT investments in the OMB Fiscal Year 2010 Exhibit 53, which provided the basis for our selection of the 16 case study programs.

Most Programs’ Cost Estimates Partially Reflected Key Practices for Developing a Comprehensive Estimate

Most programs partially implemented key practices needed to develop a comprehensive cost estimate. Specifically, of the 16 programs, 1 fully implemented the practices for establishing a comprehensive cost estimate, 12 partially implemented the practices, and 3 did not implement them.



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- DOD's Consolidated Afloat Networks and Enterprise Services program fully implemented key practices for developing a comprehensive cost estimate. Specifically, the program's cost estimate included both the government and contractor costs for the program over its full life cycle, from inception through design, development, deployment, operation and maintenance, and retirement of the program. Further, the cost estimate reflected the current program and technical parameters, such as the acquisition strategy and physical characteristics of the system. In addition, the estimate clearly described how the various cost subelements were summed to produce the amounts for each cost category, thereby ensuring that all pertinent costs were included, and no costs were double counted. Lastly, cost-influencing ground rules and assumptions, such as the program's schedule, labor rates, and inflation indexes, were documented.
  - Twelve programs partially implemented key practices for developing a comprehensive cost estimate. Most of these programs fully identified cost-influencing ground rules and assumptions and included government and contractor costs for portions of the program life cycle. However, 10 of the 12 programs did not include the full costs for all life-cycle phases and other important aspects of the program, such as costs expected to be incurred by organizations outside of the acquiring program (e.g., by other agency subcomponents), all costs for operating and maintaining the system, and costs for the retirement of the system. Without fully accounting for all past, present, and future costs for every aspect of the program, regardless of funding source, the programs' estimated costs are likely understated and thereby subject to underfunding and cost overruns.

In addition, 10 of the 12 programs did not provide evidence that their cost estimates completely defined the program or reflected the current program schedule by documenting a technical baseline description to provide a common definition of the current program, including detailed technical, program, and schedule descriptions of the system. For example, in 2008, Homeland Security's Rescue 21 program documented the system's technical characteristics, along with a high-level schedule for the program. Since 2008, however, certain technical characteristics of the program had changed, such as additional deployment sites needed to address communication service gaps identified by local commanders at previously deployed locations. In addition, the planned deployment dates for several locations of the system had been delayed. As a result, the program's cost estimate did not fully reflect the current scope and schedule of the program.

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Understanding the program—including the acquisition strategy, technical definition, characteristics, system design features, and technologies to be included—is critical to developing a reliable cost estimate. Without these data, programs will not be able to identify the technical and program parameters that bind the estimate.

- Three programs did not implement key practices for developing a comprehensive cost estimate in that their estimates did not adequately (1) include all costs over the program’s full life cycle; (2) completely define the program or the current schedule; (3) include a detailed, product-oriented work breakdown structure; and (4) document cost-influencing ground rules and assumptions. For example, the cost estimate for Veterans Affairs’ Health Data Repository program did not include sufficient detail to show that it accounted for all phases of the program’s life cycle (e.g., design, development, and deployment). Further, the estimate did not include important technical baseline information, including the technical, program, and schedule aspects of the system being estimated. Lastly, the estimate only used high-level budget codes rather than a detailed, product-oriented cost element structure to decompose the work, and ground rules and assumptions (e.g., labor rates and base-year dollars) were not documented. Without implementing key practices for developing comprehensive cost estimates, management and oversight organizations cannot be assured that a program’s estimate is complete and accounts for all possible costs, thus increasing the likelihood that the estimate is understated.

Most Programs’ Cost Estimates Partially Reflected Key Practices for Developing a Well-Documented Estimate

The majority of programs partially implemented key practices needed to develop a well-documented cost estimate. Specifically, of the 16 programs, 1 fully implemented the practices for establishing a well-documented cost estimate, 10 partially implemented the practices, and 5 did not implement them.

- DOD’s Consolidated Afloat Networks and Enterprise Services program fully implemented key practices for developing a well-documented cost estimate. Specifically, the program’s cost estimate captured in writing the source data used (e.g., historical data and program documentation), the calculations performed and their results, and the estimating methodology used to derive each cost element. In addition, the program documented a technical baseline description that included, among other things, the relationships with other systems and planned performance parameters. Lastly, the cost estimate was reviewed both by the Naval Center for Cost Analysis and the Assistant Secretary of the Navy for Research, Development,

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and Acquisition, which helped ensure a level of confidence in the estimating process and the estimate produced.

- Ten programs partially implemented key practices for developing a well-documented cost estimate. Most of these programs included a limited description of source data and methodologies used for estimating costs, and documented management approval of the cost estimate. However, 9 of the 10 programs did not include complete documentation capturing source data used, the calculations performed and their results, and the estimating methodology used to derive each cost element. Among other things, the 9 programs had weaknesses in one or more of the following areas: relying on expert opinion but lacking historical data or other documentation to back up the opinions; not documenting their estimate in a way that a cost analyst unfamiliar with the program could understand what was done and replicate it; and lacking supporting data that could be easily updated to reflect actual costs or program changes. Without adequate documentation to support the cost estimate, questions about the approach or data used cannot be answered and the estimate may not be useful for updates or information sharing.

In addition, 8 of the 10 programs did not provide management with sufficient information about how the estimate was developed in order to make an informed approval decision. For example, while the EPA's Financial System Modernization Project's cost estimate was approved, management was not provided information specific to how the estimate was developed, including enough detail to show whether it was accurate, complete, and high in quality. Because cost estimates should be reviewed and accepted by management on the basis of confidence in the estimating process and the estimate produced by the process, it is imperative that management understand how the estimate was developed, including the risks associated with the underlying data and methods, in making a decision to approve a cost estimate.

- Five programs did not implement key practices for developing a well-documented cost estimate in that their estimates did not adequately (1) include detailed documentation that described how the estimate was derived, (2) capture the estimating process in such a way that the estimate can be easily replicated and updated, (3) discuss the technical baseline description, and (4) provide evidence that the

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estimate was fully reviewed and accepted by management. In particular, three of the five programs relied on their budget submission documentation, known as the OMB Exhibit 300,<sup>26</sup> as their life-cycle cost estimate. The cost estimate information included in these programs' Exhibit 300 budget submissions was limited to the final estimates in certain phases of the program's life cycle, such as planning, development, and operations and maintenance. Because a well-documented estimate includes detailed documentation of the source data, calculations and results, and explanations of why particular methods and references were chosen, the programs that relied on their Exhibit 300 budget submissions as their cost estimates lacked the level of rigor and supporting documentation necessary for a well-documented cost estimate. Without a well-documented estimate, a program's credibility may suffer because the documentation cannot explain the rationale of the methodology or the calculations, a convincing argument of the estimate's validity cannot be presented, and decision makers' questions cannot be effectively answered.

**Most Programs' Cost Estimates Partially Reflected or Did Not Reflect Key Practices for Developing an Accurate Estimate**

Most programs partially implemented or did not implement key practices needed to develop an accurate cost estimate. Specifically, of the 16 programs, 2 fully implemented the practices for establishing an accurate cost estimate, 8 partially implemented the practices, and 6 did not implement them.

- DOD's Consolidated Afloat Networks and Enterprise Services and Homeland Security's Integrated Public Alert and Warning System programs fully implemented key practices for developing an accurate cost estimate. Specifically, the programs' estimates were based on an assessment of most likely costs, in part because a risk and uncertainty analysis was conducted to determine where the programs' estimates fell against the range of all possible costs. In addition, the programs' estimates were grounded in a historical record of cost estimating and actual experiences from comparable programs. For example, the cost estimate for the Integrated Public Alert and Warning System program relied, in part, on actual costs already incurred by the program as well as data from three comparable programs, including a

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<sup>26</sup>According to OMB's Circular A-11, the Exhibit 300 is used to, among other things, make decisions about budgetary resources, and further states that agencies should have the supporting evidence used to produce the Exhibit 300 readily available as part of project-specific documentation.

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legacy disaster management system. Moreover, the programs' cost estimates were adjusted for inflation and updated regularly to reflect material changes in the programs, such as when the schedule changed.

- Eight programs partially implemented key practices for developing an accurate cost estimate. Most of these programs accounted for inflation when projecting future costs. However, four of the eight programs did not rely, or could not provide evidence of relying, on historical costs and actual experiences from comparable programs. For example, officials from Pension Benefit Guaranty Corporation's Benefit Administration program stated that they relied on historical data along with expert opinion in projecting costs, but the officials did not provide evidence of the data sources or how the historical data were used. Because historical data can provide estimators with insight into actual costs on similar programs—including any cost growth that occurred in the original estimates—without documenting these data, these programs lacked an effective means to challenge optimistic assumptions and bring more realism to their estimates.

In addition, six of the eight programs did not provide evidence that they had regularly updated their estimates to reflect material changes in the programs so that they accurately reflected the current status. For example, Justice's Unified Financial Management System program developed a cost estimate in 2009; however, according to program documentation, program scope and projected costs have since changed and, as a result, the 2009 estimate no longer reflects the current program. Cost estimates that are not regularly updated with current information can make it more difficult to analyze changes in program costs, impede the collection of cost and technical data to support future estimates, and may not provide decision makers with accurate information for assessing alternative decisions.

- Six programs did not implement key practices for developing an accurate cost estimate in that their estimates were not adequately (1) based on an assessment of most likely costs, (2) grounded in historical data and actual experiences from comparable programs, (3) adjusted for inflation, and (4) updated to ensure that they always reflect the current status of the program. For example, the cost estimate for Agriculture's Public Health Information System was not based on an assessment of most likely costs because a risk and uncertainty analysis was not conducted to determine where the estimate fell against the range of all possible costs. In addition, the

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estimate was based primarily on the program team's expertise, but was not grounded in historical costs or actual experiences from comparable programs. Lastly, the estimate was not adjusted for inflation and lacked adequate detail to determine whether the program's latest updates to the cost estimate, completed in 2011, accurately reflected the current status of the program. Without implementing key practices for developing an accurate cost estimate, a program's estimate is more likely to be biased by optimism and subject to cost overruns, and may not provide management and oversight organizations with accurate information for making well-informed decisions.

**Most Programs' Cost Estimates Did Not Reflect Key Practices for Developing a Credible Estimate**

The majority of programs did not implement all key practices needed to develop a credible cost estimate. Specifically, of the 16 programs, 1 fully implemented the practices for establishing a credible cost estimate, 5 partially implemented the practices, and 10 did not implement them.

- DOD's Consolidated Afloat Networks and Enterprise Services program fully implemented key practices for developing a credible cost estimate. Specifically, the program performed a complete uncertainty analysis (i.e., both a sensitivity analysis and Monte Carlo simulation<sup>27</sup>) on the estimate. For example, in performing the sensitivity analysis, the program identified a range of possible costs based on varying key parameters, such as the technology refresh cycle and procurement costs. In addition, the program performed cross checks (using different estimating methods) on key cost drivers, such as system installation costs. Lastly, an independent cost estimate was conducted by the Naval Center for Cost Analysis and the results were reconciled with the program's cost estimate, which increased the confidence in the credibility of the resulting estimate.
- Five programs partially implemented key practices for developing a credible cost estimate. Specifically, three of the five programs performed aspects of a sensitivity analysis, such as varying one or two assumptions to assess the impact on the estimate; however, these programs did not perform other important components, such as documenting the rationale for the changes to the assumptions or assessing the full impact of the changes to the assumptions by

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<sup>27</sup>A Monte Carlo simulation assesses the aggregate variability of the cost estimate to determine a confidence range around the cost estimate.

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determining a range of possible costs. For example, the Pension Benefit Guaranty Corporation's Benefits Administration program performed a sensitivity analysis by varying three program assumptions, one of which was the contractor's hourly rate, to assess the impact on the cost estimate. However, the program did not provide evidence to support why the adjusted hourly labor rate was used nor apply a range of increases and decreases to the hourly labor rate to determine the level of sensitivity of this assumption on the cost estimate. A comprehensive sensitivity analysis that is well documented and traceable can provide programs with a better understanding of the variables that most affect the cost estimate and assist in identifying the cost elements that represent the highest risk.

In addition, three of the five programs adjusted the cost estimate to account for risk and uncertainty, but did not provide evidence to support how costs were risk adjusted or determine the level of confidence associated with the cost estimate.<sup>28</sup> For example, Homeland Security's Integrated Public Alert and Warning System program's cost estimate did not include information on the risks considered in its risk and uncertainty analysis or consider the relationship between multiple cost elements when accounting for risks. Without conducting an adequate risk and uncertainty analysis, the cost estimate may be unrealistic because it does not fully reflect the aggregate variability from such effects as schedule slippage, mission changes, and proposed solutions not meeting users' needs.

- Ten programs did not implement key practices for developing a credible cost estimate in that the programs did not adequately (1) assess the uncertainty or bias surrounding data and assumptions by conducting a sensitivity analysis, (2) determine the level of risk associated with the estimate by performing a risk and uncertainty analysis, (3) cross-check the estimates for key cost drivers, and (4) commission an independent cost estimate to be conducted by a group outside the acquiring organization to determine whether other estimating methods would produce similar results. For example,

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<sup>28</sup>Because uncertainty cannot be avoided, it is necessary to conduct a risk and uncertainty analysis to determine the level of confidence associated with the cost estimate. The level of confidence is the probability that the cost estimate will actually be met. For example, if the confidence level is 80 percent, there is an 80 percent chance that the final cost will be at or below the cost estimate and a 20 percent chance that costs will exceed the cost estimate.

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Agriculture's Web-Based Supply Chain Management program did not conduct a sensitivity analysis to better understand which variables most affected the cost estimate, nor did the program conduct a risk and uncertainty analysis to quantify the impact of risks on the estimate. Further, cost drivers were not cross-checked to see if different estimating methodologies produced similar results, and an independent cost estimate was not conducted to independently validate the results of the program's estimate. Without implementing key practices for developing a credible cost estimate, a program may lack an understanding of the limitations associated with the cost estimate and be unprepared to deal with unexpected contingencies.

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### Inadequate Implementation Was Largely Due to Weaknesses in Policy

The lack of reliable cost estimates across the investments exists in part because of the weaknesses previously identified in the eight agencies' cost-estimating policies. More specifically, program officials at five agencies—Agriculture, Commerce, EPA, Justice, and Veterans Affairs—attributed weaknesses in their programs' cost estimates, in part, to the fact that agency policies did not require cost-estimating best practices—deficiencies which we also identified in these agencies' policies. For example, officials at Commerce's Comprehensive Large Array-data Stewardship System program stated that, when the program developed its cost estimate, no agency guidance existed regarding the process to follow in developing the estimate. In addition, officials at Veterans Affairs' Veteran's Benefits Management System program stated that they did not perform a risk analysis on their cost estimate because agency guidance on how such an analysis should be performed did not exist. In certain cases, officials stated that program cost estimates were initially developed prior to 2007, when a comprehensive federal resource for cost-estimating best practices, such as GAO's cost guide,<sup>29</sup> did not exist. However, all 16 programs included in our review have either developed new estimates or updated previous estimates since 2007; nonetheless, as previously mentioned, most of the selected agencies' policies did not fully address compliance with cost-estimating best practices, including the five agencies mentioned above. If these agencies had updated their policies, programs would have been more likely to follow a standard, high-quality process in developing or updating their cost estimates.

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<sup>29</sup>[GAO-09-3SP](#). The GAO cost guide was first released as an exposure draft in July 2007. See GAO, *Cost Assessment Guide: Best Practices for Estimating and Managing Program Costs, Exposure Draft*, [GAO-07-1134SP](#) (Washington, D.C.: July 2007).



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Until important cost-estimating practices are fully implemented, the likelihood that these programs will have to revise their current cost estimates upward is increased. Collectively, 13 of the 16 programs have already revised their original life-cycle cost estimates upward by almost \$5 billion due, in part, to weaknesses in program cost-estimating practices (see app. III for details on changes in the programs' cost estimates over time). For example, in many cases, cost estimates had to be revised upwards to reflect the incorporation of full costs for all life-cycle phases (e.g., development or operations and maintenance), which had not originally been included. This resulted, in some cases, in significant increases to estimated life-cycle costs. Other reasons that programs cited for revising their life-cycle cost estimates upward included changes to program or system requirements, schedule delays, technology upgrades, and system defects, among other things. Further, as previously mentioned, 13 of the 16 case study programs still have cost estimates that do not include the full costs for all life-cycle phases, which significantly increases the risk that these programs' cost estimates will continue to be revised upward in the future.

Without reliable cost estimates, the 15 programs that did not fully meet best practices will not have a sound basis for informed program decision making, realistic budget formulation and program resourcing, and meaningful progress measurement. Consequently, nearly all of these programs' cost estimates may continue to be understated and subject to underfunding and cost overruns.

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## Conclusions

Given the enormous size of the federal government's investment in IT, it is critical that such investments are based on reliable estimates of program costs. While all of the selected agencies have established policies that at least partially addressed a requirement for programs to develop full life-cycle cost estimates, most of the agencies' policies have significant weaknesses. With the exception of DOD, these policies omit or lack sufficient guidance on several key components of a comprehensive policy including, for example, management review and acceptance of program cost estimates, the type of work structure needed to effectively estimate costs, and training requirements for all relevant personnel. Without comprehensive policies, agencies may not have a sound basis for making decisions on how to most effectively manage their portfolios of projects.

Most programs' estimates at least partially reflected cost-estimating best practices, such as documenting cost-influencing ground rules and

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assumptions; however, with the exception of DOD's Consolidated Afloat Networks and Enterprise Services program, the programs we reviewed had not established fully reliable cost estimates, increasing the likelihood that the estimates are incomplete and do not account for all possible costs. For example, without including costs for all phases of a program's life cycle and performing a comprehensive risk and uncertainty analysis, a program's estimated costs could be understated and subject to underfunding and cost overruns, putting it at risk of being reduced in scope or requiring additional funding to meet its objectives. Many of the weaknesses found in these programs can be traced back to inadequate agency cost-estimating policies. Without better estimates of acquisition life-cycle costs, neither the programs nor the agencies have reliable information for supporting program and budget decisions. Consequently, the likelihood of cost overruns, missed deadlines, and performance shortfalls is significantly increased.

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## Recommendations for Executive Action

To address weaknesses identified in agencies' policies and practices for cost estimating, we are making the following recommendations:

We recommend that the Secretaries of Agriculture, Commerce, Homeland Security, Labor, and Veterans Affairs, the Attorney General, and the Administrator of the Environmental Protection Agency direct responsible officials to modify policies governing cost estimating to ensure that they address the weaknesses that we identified.

We also recommend that the Secretaries of Agriculture, Commerce, Homeland Security, Labor, and Veterans Affairs, the Attorney General, the Administrator of the Environmental Protection Agency, and the Director of the Pension Benefit Guaranty Corporation direct responsible officials to update future life-cycle cost estimates of the system acquisition programs discussed in this report using cost-estimating practices that address the detailed weaknesses that we identified.

Lastly, although DOD fully addressed the components of an effective cost-estimating policy, in order to address the weaknesses we identified with a key system acquisition discussed in this report, we recommend that the Secretary of Defense direct responsible officials to update future life-cycle cost estimates of the Tactical Mission Command program using cost-estimating practices that address the detailed weaknesses that we identified.

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## Agency Comments and Our Evaluation

We provided the selected eight agencies and the Pension Benefit Guaranty Corporation with a draft of our report for review and comment. A management analyst in the Department of Justice's Internal Review and Evaluation Office, Justice Management Division, responded orally that the department had no comments. Six of the agencies and the Pension Benefit Guaranty Corporation provided written comments, and the Department of Labor provided oral and written comments. These agencies generally agreed with our results and recommendations, although EPA disagreed with our assessment of the cost-estimating practices used for one of its programs. These agencies also provided technical comments, which we incorporated in the report as appropriate.

The comments of the agencies and the corporation are summarized below:

- The U.S. Department of Agriculture's Acting Chief Information Officer stated that the department concurred with the content of the report. Agriculture's comments are reprinted in appendix IV.
- The Acting Secretary of Commerce stated that the department fully concurred with our findings and recommendations. Among other things, the Acting Secretary described a number of ongoing actions to address the weaknesses we identified, such as modifying departmental policies governing cost estimating to include an additional cost-estimating training course and cost-estimating training requirements. In addition, the department stated that forthcoming policy and guidance are intended to ensure that the cost estimates for high-profile programs are comprehensive, accurate, credible, and well-documented. Commerce's comments are reprinted in appendix V.
- DOD's Director of Cost Assessment and Program Evaluation stated that the department partially concurred with our recommendation but agreed with the criteria, methodology, and assessment of the DOD programs. The director added, however, that there is no plan to formally update the Tactical Mission Command life-cycle cost estimate, as the program is in the system deployment phase of its acquisition lifecycle. We recognize that the programs included in our study are at varying stages of their acquisition life cycles and that updates to their cost estimates may not be justified. Accordingly, our recommendation to DOD is specific to only future life-cycle cost estimates. In this regard, if any significant changes occur in the program during deployment of the system that warrant an update to

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the cost estimate, it will be important that the program uses best practices that address the weaknesses we identified. DOD's comments are reprinted in appendix VI.

- EPA's Assistant Administrator of the Office of Solid Waste and Emergency Response and its Assistant Administrator and Chief Information Officer of the Office of Environmental Information stated, in regard to our assessment of cost-estimating policies, that EPA recognized that its policies did not require cost-estimating best practices and that the agency will update its Systems Life Cycle Management procedures accordingly. The officials acknowledged that sound fiscal management practices should be followed in all aspects of the agency's information technology operations, including cost estimating for the development of new systems.

In regard to our assessment of cost-estimating practices for two system acquisition programs, EPA stated that it did not have any comments on our assessment of the Financial System Modernization Project; however, it did not believe our assessment accurately reflected the cost-estimating practices employed for the development of the Superfund Enterprise Management System. In particular, the Office of Solid Waste and Emergency Response stated in its written response and in technical comments that it believed it had met the spirit and intent of the cost-estimating best practices in GAO's cost guide, even though the program may have used different processes or documentation in order to do so. We recognize and agree that organizations should tailor the use of the cost-estimating best practices as appropriate based on, for example, the development approach being used, and we took this factor into consideration during our review of the 16 acquisition programs. However, we stand by our assessment of the Superfund Enterprise Management System program's cost estimate on the basis of the weaknesses described in appendix II of this report. In particular, as we discuss, the program's cost estimate lacked key supporting documentation, including costs not documented at a sufficient level of detail; the lack of documented source data, calculations, and methodologies used to develop the estimate; and a lack of documentation on the source of and rationale for the inflation factor used. In addition, the lack of detailed cost-estimate information precluded us from making the linkage between the cost estimate and other important program documents, such as the system's technical baseline and schedule, in order to determine whether the estimate reflects the current program and status. Because rigorous documentation is essential for justifying how an estimate was developed and for presenting a convincing argument for

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an estimate's validity, weaknesses in this area contributed significantly to weaknesses across multiple best practices areas, including the estimate's comprehensiveness and accuracy. Further, regarding the Office of Solid Waste and Emergency Response's comment that our cost-estimating guide was not published until 3 years after development of the Superfund Enterprise Management System commenced, we disagree that this would preclude the program from satisfying cost-estimating best practices. Specifically, the program updated its cost estimate in 2011, 2 years after the issuance of the GAO cost guide. At that time, the program could have revised its cost estimate using available best practice guidance.

Lastly, we disagree that the draft report erroneously concluded that the Superfund Enterprise Management System cost estimate increased from \$39.3 million to \$62.0 million in just 2 years. In its written response, the Office of Solid Waste and Emergency Response stated that the revised cost estimate was a direct result of an increase in the duration of operations and maintenance from fiscal year 2013 (in the \$39.3 million estimate) to fiscal year 2017 (in the \$62.0 million estimate). However, according to documentation provided by the Superfund Enterprise Management System program, the \$39.3 million estimate, which was completed in 2009, was based on a 10-year life cycle (from fiscal year 2007 to fiscal year 2017) and included costs for operations and maintenance through fiscal year 2017. Subsequently, in 2011, the program revised its estimate to approximately \$62.0 million, which was also based on a 10-year life cycle (from fiscal year 2007 to fiscal year 2017) and included operations and maintenance costs through 2017. The revised estimate is an increase of about \$22.7 million over the initial estimate. According to program documentation, this change in the cost estimate was primarily due to the inclusion of additional operations and maintenance costs for data and content storage and hosting for the fully integrated system between fiscal year 2014 and fiscal year 2017, which were erroneously omitted from the 2009 estimate. Based on these factors, we maintain that our report reflects this information appropriately. EPA's comments are reprinted in appendix VII.

- The Department of Homeland Security's Director of the Departmental GAO-Office of the Inspector General Liaison Office stated that the department concurred with our recommendations. Among other things, the department stated that its Office of Program Accountability and Risk Management intends to develop a revised cost-estimating policy that will further incorporate cost-estimating best practices, as well as work to provide cost-estimating training to personnel on major

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programs throughout the department. Homeland Security's comments are reprinted in appendix VIII.

- In oral comments, the Administrative Officer in the Department of Labor's Office of the Assistant Secretary for Administration and Management stated that the department generally agreed with our recommendations. Further, in written comments, the Assistant Secretary for Administration and Management stated that the department, through several initiatives, such as its Post Implementation Review process and training to IT managers, will continue to improve upon its IT cost estimation. The department also commented on certain findings in our draft report. In particular, the Assistant Secretary stated that, given the department's relatively small IT portfolio, establishing a central, independent office dedicated to cost estimating is not justified. We recognize that agency IT portfolios vary in size; however, as noted in our report, agencies should establish a central cost-estimating team commensurate with the size of their agency, which could consist of a few resident experts instead of a full independent office. Regarding our second recommendation, according to the Assistant Secretary, the Occupational Safety and Health Administration (OSHA) stated that it believes our assessment of the credibility of the OSHA Information System program's 2010 cost estimate was too low and did not reflect additional information provided in support of the program's 2008 cost estimate. In our assessment of the program's 2010 estimate we acknowledge evidence provided from the 2008 estimate; however, this evidence did not adequately show that important practices for ensuring an estimate's credibility, including making adjustments to account for risk and conducting a sensitivity analysis, were performed on the 2010 cost estimate. In addition, OSHA stated that an independent estimate was conducted at the outset of the program by an industry-leading IT consulting firm as recommended by the Department of Labor Office of the Inspector General. While we acknowledge that this was done in 2005, the resulting estimate was the only one developed at the time and thus was not used as a means of independent validation—i.e., to determine whether multiple estimating methods produced similar results. Therefore, the independent estimate conducted in 2005 would not increase the credibility of the program's current cost estimate. Labor's comments are reprinted in appendix IX.
- The Director of the Pension Benefit Guaranty Corporation stated that the corporation was pleased that its selected IT investment met at least half, or a large portion, of our quality indicators for cost estimating. Further, the Director stated that the corporation will

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evaluate and improve future life-cycle cost estimates for the Benefit Administration investment. The Pension Benefit Guaranty Corporation's comments are reprinted in appendix X.

- The Chief of Staff for the Department of Veterans Affairs stated that the department concurred with our recommendations and has efforts under way to improve its cost-estimating capabilities. Among other things, the Chief of Staff stated that the department plans to complete, by the end of the first quarter of fiscal year 2013, an evaluation of the utility of establishing an organizational function focused solely on multiyear cost estimation. In addition, to improve cost-estimating practices on its IT efforts, the department stated that it has additional training planned in early fiscal year 2013. Veterans Affairs' comments are reprinted in appendix XI.

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As agreed with your office, 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 Secretaries of Agriculture, Commerce, Defense, Homeland Security, Labor, and Veterans Affairs; the Attorney General; the Administrator of the Environmental Protection Agency; the Director of the Pension Benefit Guaranty Corporation; and other interested parties. In addition, the report will be available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions concerning this report, please contact me at (202) 512-6304 or by e-mail at [melvinv@gao.gov](mailto:melvinv@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs are on the last page of this report. Key contributors to this report are listed in appendix XII.

Sincerely yours,



Valerie C. Melvin  
Director  
Information Management and Technology Resources Issues

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# Appendix I: Objectives, Scope, and Methodology

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Our objectives were to (1) assess the extent to which selected departments and agencies have appropriately implemented cost-estimating policies and procedures, and (2) evaluate whether selected information technology (IT) investments at these departments and agencies have reliable cost estimates to support budget and program decisions. For this review, we assessed eight federal agencies and 16 investments.

To select these agencies and investments, we relied on the Office of Management and Budget's Fiscal Year 2010 Exhibit 53<sup>1</sup> which, at the time we made our selections, contained the most current and complete data on 28 agencies' planned IT spending.<sup>2</sup> To ensure that we selected agencies with varying levels of spending on IT, we sorted them into three ranges based on their planned spending in fiscal year 2010:

- greater than or equal to \$10 billion;
- greater than or equal to \$1 billion but less than \$10 billion; and
- greater than \$0, but less than \$1 billion.

The number of agencies selected from each range was based on the relative number of IT investments within each range, and the specific agencies selected were those with the highest amount of planned IT spending in fiscal year 2010. Specifically, we selected one agency with

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<sup>1</sup>While the Office of Management and Budget's Fiscal Year 2011 Exhibit 53 was available at the time we made our agency and investment selections, it did not contain a complete set of data. Specifically, the IT investment spending data for two agencies—the Department of Defense and the Department of Energy—were not included. Therefore, we relied on the Fiscal Year 2010 Exhibit 53 for our agency and investment selection because, at the time, it was the most current and complete set of data.

<sup>2</sup>The 28 departments and agencies included in the Office of Management and Budget Fiscal Year 2010 Exhibit 53 are the departments of Agriculture, Commerce, Defense, Education, Energy, Health and Human Services, Homeland Security, Housing and Urban Development, the Interior, Justice, Labor, State, Transportation, the Treasury, and Veterans Affairs; the Environmental Protection Agency, General Services Administration, National Aeronautics and Space Administration, National Archives and Records Administration, National Science Foundation, Nuclear Regulatory Commission, Office of Management and Budget, Office of Personnel Management, Small Business Administration, Smithsonian Institution, Social Security Administration, U.S. Agency for International Development, and U.S. Army Corps of Engineers.



greater than \$10 billion in planned IT spending,<sup>3</sup> five agencies with between \$1 billion and \$10 billion in planned spending, and two agencies with less than \$1 billion in planned spending. In doing so, we limited our selections to those agencies at which we could identify two investments that met our selection criteria for investments (see the following paragraph for a discussion of our investment selection methodology). These agencies were the Departments of Agriculture, Commerce, Defense, Homeland Security, Justice, Labor, and Veterans Affairs, and the Environmental Protection Agency. We excluded the Departments of Education, Health and Human Services, and the Treasury, and the General Services Administration from our selection, even though they initially met our agency selection criteria, because we could not identify two investments at these agencies that met our investment selection criteria.

To ensure that we examined significant investments, we sorted each agency's planned IT investments based on its total planned spending for fiscal year 2010. Limiting the number of investments to two per agency, we then selected investments based on a consideration of whether they were considered major, or mission critical, by the agencies<sup>4</sup>; had significant development or technical refresh work under way; and from different subcomponents of the agency.<sup>5</sup> In doing so, we also excluded investments if they were a combination of smaller investments, were

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<sup>3</sup>Only one agency, the Department of Defense, had greater than \$10 billion in IT spending in fiscal year 2010.

<sup>4</sup>The Office of Management and Budget defines a major IT investment as a system or an acquisition requiring special management attention because it has significant importance to the mission or function of the agency, a component of the agency, or another organization; is for financial management and obligates more than \$500,000 annually; has significant program or policy implications; has high executive visibility; has high development, operating, or maintenance costs; is funded through other than direct appropriations; or is defined as major by the agency's capital planning and investment control process.

<sup>5</sup>One investment selected from the Department of Labor is the responsibility of the Pension Benefit Guaranty Corporation (PBGC). PBGC is a wholly owned government corporation administered by a presidentially appointed, Senate-confirmed Director, overseen by a Board of Directors consisting of the Secretaries of Labor, the Treasury, and Commerce. Although not a component of the Department of Labor, for administrative purposes, PBGC is included within the department's budget submission documentation. Therefore, PBGC's IT investments were included among the Department of Labor's IT investments in the Office of Management and Budget Fiscal Year 2010 Exhibit 53, which provided the basis for our selection of the 16 case study programs.

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primarily an infrastructure investment, had a high percentage of steady-state<sup>6</sup> spending versus development spending, had less than \$5 million in planned spending for fiscal year 2010, or were the subjects of recent or ongoing GAO audit work.

To assess the extent to which selected agencies had appropriately implemented cost-estimating policies and procedures, we analyzed agency policies and guidance for cost estimating. Specifically, we compared these policies and guidance documents to best practices recognized within the federal government and private industry for cost estimating. These best practices are contained in the GAO Cost Guide and include, for example, establishing a clear requirement for cost estimating, requiring management review and approval of cost estimates, and requiring and enforcing training in cost estimating.<sup>7</sup> For each policy component, we assessed it as either being not met—the agency did not provide evidence that it addressed the policy component or provided evidence that it minimally addressed the policy component; partially met—the agency provided evidence that it addressed about half or a large portion of the policy component; or fully met—the agency provided evidence that it fully addressed the policy component. We also interviewed key agency officials to obtain information on their ongoing and future cost-estimating plans.

To evaluate whether the selected IT investments have reliable cost estimates to support budget and program decisions, we analyzed program documentation, including program life-cycle cost estimates, business cases, and budget documentation; program and management review briefings and decision memoranda; integrated master schedules; and earned value management and other reports. Specifically, we compared program documentation to cost-estimating best practices as identified in the GAO cost guide and assessed programs against the four characteristics of a reliable estimate—comprehensive, well-documented, accurate, and credible. For each characteristic, we assessed multiple practices as being not met—the program did not provide evidence that it implemented the practices or provided evidence that it only minimally

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<sup>6</sup>Steady state refers to operating and maintaining systems at current levels (i.e., without major enhancements).

<sup>7</sup>GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, [GAO-09-3SP](#) (Washington, D.C.: March 2009).

implemented the practices; partially met—the program provided evidence that it implemented about half or a large portion of the practices; or fully met—the program provided evidence that it fully implemented the practices. We then summarized these assessments by characteristic. We also interviewed program officials to obtain clarification on how cost-estimating practices are implemented and how the cost estimates are used to support budget and program decisions.

We conducted this performance audit from July 2011 to July 2012 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

# Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices

We conducted case studies of 16 major system acquisition programs (listed in table 5). For each of these programs, the remaining sections of this appendix provide the following: a brief description of the program and its life-cycle cost estimate, and an assessment of the program's cost estimate against the four characteristics of a reliable cost estimate—comprehensive, well-documented, accurate, and credible.

**Table 5: Case Study Programs**

Agency	Program
Agriculture	Public Health Information System
	Web-Based Supply Chain Management
Commerce	Comprehensive Large Array-data Stewardship System
	Patents End-to-End: Software Engineering
Defense	Consolidated Afloat Networks and Enterprise Services
	Tactical Mission Command
Environmental Protection Agency	Financial System Modernization Project
	Superfund Enterprise Management System
Homeland Security	Integrated Public Alert and Warning System
	Rescue 21
Justice	Next Generation Combined DNA Index System
	Unified Financial Management System
Labor	OSHA <sup>a</sup> Information System
	PBGC <sup>b</sup> Benefit Administration
Veterans Affairs	Health Data Repository
	Veterans Benefits Management System

Source: GAO analysis of program data.

<sup>a</sup>Occupational Safety and Health Administration.

<sup>b</sup>Pension Benefit Guaranty Corporation. PBGC is a wholly owned government corporation administered by a presidentially appointed, Senate-confirmed Director and overseen by a Board of Directors consisting of the Secretaries of Labor, the Treasury, and Commerce. Although not a component of the Department of Labor, for administrative purposes, PBGC is included within the department's budget submission documentation. Therefore, PBGC's IT investments (including Benefit Administration) were included among the Department of Labor's IT investments in the Office of Management and Budget Fiscal Year 2010 Exhibit 53, which provided the basis for our selection of the 16 case study programs.

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**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

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The key below defines “fully met,” “partially met,” and “not met” as assessments of programs’ implementation of cost-estimating best practices.

<b>Key description</b>	<b>Key</b>
The program provided evidence that it fully implemented the cost-estimating practices.	Fully met
The program provided evidence that it implemented about half or a large portion of the cost-estimating practices.	Partially met
The program did not provide evidence that it implemented the practices or provided evidence that it only minimally implemented the cost-estimating practices.	Not met

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## Public Health Information System

### Investment Details

U.S. Department of Agriculture (Food Safety and Inspection Service)

Program start date: 2007

Full operational capability:

- Current: 2013
- Original: 2010

Total life-cycle cost:

- Current: \$82.3 million
- Original: Not applicable<sup>a</sup>

Current life-cycle phase: Mixed (development/operations and maintenance)

Source: Agency data.

<sup>a</sup>PHIS was originally part of the Public Health Information Consolidation Projects investment and, therefore, did not have a life-cycle cost estimate at the time of origination.

The Public Health Information System (PHIS) program is designed to modernize the Food Safety and Inspection Service's systems for ensuring the safety of meat, poultry, and egg products. According to the agency, the current systems environment includes multiple, disparate legacy systems that do not effectively support agency operations. PHIS is intended to replace these legacy systems with a single, web-based system that addresses major business areas such as domestic inspection, import inspection, and export inspection. The program intends to implement functionality to support domestic inspection and import inspection in 2012, and export inspection in 2013.

In 2007, PHIS was a development contract within the larger Public Health Information Consolidation Projects investment. In 2011, after PHIS was separated out as its own major investment and the program was rebaselined, the PHIS program developed its own cost estimate of \$82.3 million. This includes \$71.4 million for development and \$10.9 million for operations and maintenance over a 12-year life cycle.

The PHIS program's current cost estimate does not exhibit all of the qualities of a reliable cost estimate. Specifically, while the estimate partially reflects key practices for developing a comprehensive estimate, it does not reflect key practices for developing a well-documented, accurate, or credible estimate. Table 6 provides details on our assessment of the PHIS program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 6: Assessment of the PHIS Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The estimate includes government and contractor costs over portions of the life cycle of the program (e.g., development and retirement), but does not include at least 10 years of operations and maintenance costs to account for at least one software technical refresh cycle. Further, while the estimate is supported by a limited technical baseline description, such as high-level schedule milestones, the information lacks adequate detail and cannot be used to determine whether the estimate completely defines and reflects the current program. A technical baseline description should provide a common definition of the program, including detailed technical, program, and schedule descriptions of the system. In addition, the estimate is only decomposed into yearly government and contractor costs rather than into a cost element structure with sufficient detail to provide assurance that cost elements are neither omitted nor double-counted. Lastly, the estimate does not include ground rules and assumptions (e.g., labor rates and base-year dollars). Documenting all assumptions is imperative to ensuring that management fully understands the conditions under which the estimate was structured.
Well-documented	Not met	While the estimate was documented in the program's December 2011 request to the department's Office of the Chief Information Officer to revise the PHIS cost and schedule baseline, the document only included limited technical baseline information, such as high-level schedule milestones, and the resulting cost estimates. In particular, the program's documentation did not include the data sources, calculations and their results, and methodologies used in developing the estimate. Instead, PHIS program officials stated that the team relied on its expertise and previous experiences. However, without rigorous documentation, an analyst unfamiliar with the program would not be able to understand and replicate the cost estimate and the estimate is not useful for updates or information sharing. Further, although the estimate has been reviewed and approved by management, the information presented to management did not include adequate detail, such as information about how the estimate was developed and the risks associated with the underlying data and methods. Without such information, management cannot have confidence in the estimating process or the estimate produced by the process.
Accurate	Not met	In developing the estimate, the program relied on the team's expertise and previous experiences in place of historical costs or actual experiences from comparable programs, which can be used to challenge optimistic assumptions and bring more realism to the estimate. Officials stated this was due to a lack of available historical cost data. Further, the estimate is not based on an assessment of most likely costs, because the program did not rely on historical data and a risk and uncertainty analysis was not conducted to determine where the estimate fell against the range of all possible costs. In addition, the estimate was not adjusted for inflation. Adjusting for inflation is important because cost data must be expressed in consistent terms, or cost overruns can result. Lastly, the estimate lacks adequate detail to be able to determine whether the program's recent updates to the estimate reflect the current status of the program. For example, the program expects to spend over \$12 million on development between 2014 and 2018, despite planning to reach full operational capability in 2013 and without establishing a technical basis for these costs. As a result, decision makers cannot have confidence that the estimate accurately represents the program's full costs.
Credible	Not met	Estimated costs for key cost drivers were not cross-checked using different methodologies to see if the results were similar, a sensitivity analysis was not performed to better understand which variables most affected the cost estimate, and a risk and uncertainty analysis was not conducted to determine the confidence level associated with the estimate and recommend contingency reserves. Although program officials stated that contingency funding is held by the agency, best practices state that contingency funding should be incorporated into the program's estimate because, often, it can take months to receive additional funding to address an emerging program issue. Lastly, no steps were taken—such as an independent cost estimate—to independently validate the results of the program's estimate. Without taking these steps, the program lacks a full understanding of the limitations in the estimate and is not prepared to deal with unexpected contingencies.

Source: GAO analysis the PHIS program's cost estimate.



## Web-Based Supply Chain Management

### Investment Details

U.S. Department of Agriculture (Agricultural Marketing Service)

Program start date: 2002

Full operational capability:

- Current: 2010
- Original: 2008

Total life-cycle cost:

- Current: \$378.4 million
- Original: \$142.9 million

Current life-cycle phase: Operations and maintenance

Source: Agency data.

The Web-Based Supply Chain Management (WBSCM) program is designed to modernize the U.S. Department of Agriculture's commodity management operations, including the purchasing and distribution of approximately \$2.5 billion in food products for distribution to needy recipients through domestic and foreign food programs. To accomplish this, the program is replacing a legacy system with a web-based commercial-off-the-shelf solution. In 2010, the program achieved full operational capability. Ongoing efforts are focused on addressing a significant number of system defects identified since deployment.

In 2003, WBSCM developed an initial cost estimate of \$142.9 million. This included \$105.5 million for development and \$37.4 million for operations and maintenance over a 7-year life cycle. Subsequently, after revising the estimate each year as part the program's Office of Management and Budget Exhibit 300<sup>1</sup> submission, in 2011, WBSCM revised its cost estimate to \$378.4 million, an increase of about \$235.5 million over its initial cost estimate. This includes \$104.9 million for development and \$273.5 million for operations and maintenance over a 18-year life cycle. These changes are due to, among other things, incorporating additional years of operations and maintenance costs, a recently planned system upgrade, and additional costs associated with addressing system defects.

The WBSCM program's current cost estimate does not exhibit any of the qualities of a reliable cost estimate. Specifically, the estimate did not reflect key practices for developing a comprehensive, well-documented, accurate, or credible estimate. Table 7 provides details on our assessment of the WBSCM program's cost estimate.

<sup>1</sup>According to the Office of Management and Budget's Circular A-11, the Exhibit 300 is used to, among other things, make decisions about budgetary resources, and further states that agencies should have the supporting evidence used to produce the Exhibit 300 readily available as part of project-specific documentation.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 7: Assessment of the WBSCM Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Not met	The cost estimate did not clearly include all life-cycle costs. While it includes costs for development and operations and maintenance of the system, it lacks sufficient detail to show whether costs associated with design, deployment, and retirement of the system are included. Further, the estimate lacks adequate detail to ensure that it completely defines and reflects the current program. Specifically, the estimate is not supported by a technical baseline, which would provide a common definition of the program, including detailed technical, program, and schedule descriptions of the system. In addition, the estimate does not have a cost element structure at a sufficient level of detail, which would provide assurance that cost elements are neither omitted nor double-counted, as well as improve traceability between estimated costs and the program's scope. Lastly, the estimate does not include ground rules and assumptions (e.g., labor rates and base-year dollars). Documenting all assumptions is imperative to ensuring that management fully understands the conditions under which the estimate was structured. Without a comprehensive cost estimate, decision makers cannot be assured of having a complete view of program costs.
Well-documented	Not met	While the program's cost estimate was documented in its most recent Office of Management and Budget Exhibit 300 submission, this document only included the resulting cost estimates. In particular, this document did not provide the technical basis of the estimate, nor the data sources, calculations and their results, and methodologies used in developing the estimate. As a result, questions about the approach or data used to create the estimate cannot be answered, an analyst unfamiliar with the program would not be able to understand and replicate the program's cost estimate, and the estimate is not useful for updates or information sharing. Further, although officials stated that the cost estimate was provided to the department's Office of the Chief Information Officer for review and approval, the information presented to management did not include adequate detail, such as information about how the estimate was developed, and the program could not provide documentation demonstrating management's review and approval. Because a cost estimate is not considered valid until management has approved it, it is imperative that management understand how the estimate was developed. Without such information, management cannot have confidence in the estimating process and the estimate produced by the process.
Accurate	Not met	In developing the estimate, the program did not rely on historical costs and actual experiences from comparable programs, which can be used to challenge optimistic assumptions and bring more realism to the estimate. Further, the estimate lacks adequate detail to ensure that updates to the estimate reflect the current status of the program. For example, the program's estimate recently increased by \$90 million due to a planned software upgrade, but officials stated that there is no supporting documentation showing how these costs were derived, thus making it unclear whether the increase accurately reflects the planned work to be completed. In addition, the estimate was not properly adjusted for inflation. Adjusting for inflation is important because cost data must be expressed in consistent terms, or cost overruns can result. Lastly, the estimate is not based on an assessment of most likely costs, because the program relied heavily on the prime contractor and expert opinion in place of historical data, and a risk and uncertainty analysis was not conducted to determine where the estimate fell against the range of all possible costs. As a result, decision makers cannot have confidence that the estimate accurately represents the program's full life-cycle cost.
Credible	Not met	The WBSCM estimate is not credible because steps were not taken to understand the limitations associated with the estimate. Specifically, costs were not cross-checked using different methodologies to see if the results were similar, a sensitivity analysis was not performed to better understand which variables most affect the cost estimate, and a risk and uncertainty analysis was not conducted to determine the confidence level associated with the estimate. WBSCM program officials stated that they believed there were not any significant cost or schedule risks remaining; however, without actually taking steps to understand the limitations associated with the estimate, the program cannot have confidence that this is actually the case. Lastly, no steps were taken—such as an independent cost estimate—to independently validate the results of the program's estimate.

Source: GAO analysis the WBSCM program's cost estimate.

## Comprehensive Large Array-data Stewardship System

### Investment Details

Department of Commerce (National Oceanic and Atmospheric Administration)

Program start date: 2001

Full operational capability:

- Current: 2018
- Original: 2018

Total life-cycle cost:

- Current: \$240.0 million
- Original: \$195.5 million

Current life-cycle phase: Mixed (development/operations and maintenance)

Source: Agency data.

The Comprehensive Large Array-data Stewardship System (CLASS) is designed to provide environmental data archiving and access. The National Atmospheric and Oceanic Administration has been acquiring these data for more than 30 years, from a variety of observing systems throughout the agency and from a number of its partners. Currently, large portions of the nation's environmental data are stored and maintained in disparate systems, with nonstandard archive and access capabilities. With significant increases expected in both the data volume and the number and sophistication of users over the next 15 years, CLASS is intended to provide a standard, integrated solution for environmental data archiving and access managed at the enterprise level. CLASS is currently developing satellite data archiving and access capabilities for several satellite programs, including the next generation of geostationary satellites—known as the Geostationary Operational Environmental Satellites-R Series, which are planned for launch beginning in 2015.

In 2006, the National Oceanic and Atmospheric Administration developed the initial CLASS cost estimate of approximately \$195.5 million. This included \$118.3 million for development and \$77.2 million for operations and maintenance over a 9-year life cycle. Subsequently, after revising the cost estimate three times, in 2011, CLASS established its current cost estimate of approximately \$240.0 million, an increase of about \$44.5 million over its initial cost estimate. This includes \$176.0 million for development and \$64.0 million for operations and maintenance over a 17-year life cycle. CLASS program officials stated that the increase in the estimate was due, in part, to additional data archiving requirements and external program delays.

The CLASS program's current cost estimate does not exhibit all qualities of a reliable cost estimate. Specifically, while the estimate partially reflects key practices for developing a comprehensive estimate, it does not reflect key practices for developing a well-documented, accurate, or credible estimate. Table 8 provides details on our assessment of CLASS program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 8: Assessment of the CLASS Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The cost estimate includes certain contractor costs, such as those for planning and development, and is based on a cost element structure that is at an appropriate level of detail, in that it includes multiple levels of cost subelements that are summed to produce the totals for each cost category. However, the estimate did not include any estimated costs for operations and maintenance after the program achieves full-operational capability in 2018, nor did it include any government costs (e.g., personnel costs). Moreover, while the cost element structure is appropriately detailed, it is not product-oriented and does not define the work activities included in each cost element. Without a product-oriented structure and clearly defined cost elements, the program will not be able to identify which deliverables, such as a hardware or software component, are causing cost or schedule overruns. In addition, it cannot be determined whether the estimate completely defines the program, in part, because the program's requirements have not been finalized. Lastly, no cost-influencing ground rules and assumptions (e.g., labor rates and inflation indexes) were documented. Documenting all assumptions is imperative to ensuring that management fully understands the conditions under which the estimate was structured.
Well-documented	Not met	The cost estimate was not supported by detailed documentation that describes how it was derived. More specifically, the documentation did not capture in writing the source data used, the calculations performed and their results, and the estimating methodology used to derive each cost element. As a result, the estimate is not captured in a way such that it can be easily replicated and updated. Further, it cannot be determined whether the technical baseline is consistent with the cost estimate because, among other things, the program's requirements have not been baselined and finalized. Lastly, the program's current \$240.0 million cost estimate has not been reviewed and approved by management. Because a cost estimate is not considered valid until management has approved it, it is imperative that management understand how the estimate was developed, including the risks associated with the underlying data and methods.
Accurate	Not met	The cost estimate was not accurate because it was not based on an assessment of most likely costs. More specifically, the program did not conduct a risk and uncertainty analysis to determine where the estimate fell against the range of all possible costs, and to identify the most likely cost estimate. Moreover, the estimate was not adjusted for inflation. Adjusting for inflation is important because, in the development of an estimate, cost data must be expressed in consistent terms, or cost overruns can result. In addition, although officials stated that historical costs from similar contracts were used to develop the cost estimate, the supporting documentation provided did not provide evidence that these data were used. Lastly, the program's cost estimate does not reflect current status. More specifically, since documenting its initial estimate in 2006, the CLASS program has experienced cost, schedule, and scope changes, including changes to the program's requirements. However, the cost estimate documentation has not been regularly updated. The CLASS Program Manager stated that they are currently updating the cost estimate, which is planned to be completed in fiscal year 2012.
Credible	Not met	The program did not perform a sensitivity analysis or a risk and uncertainty analysis on the cost estimate. Because uncertainty cannot be avoided, it is necessary to identify the cost elements that represent the most risk. A sensitivity analysis reveals how the cost estimate is affected by a change in a single assumption, which helps the cost estimator understand which variables most affect the cost estimate. Moreover, a risk and uncertainty analysis can assess the variability in the cost estimate so that a level of confidence can be given about the estimate. In addition, cross-checks were not performed on major cost elements using different estimating methodologies to see if the results were similar. When cross-checks demonstrate that alternative methods produce similar results, then confidence in the estimate increases, leading to greater credibility. Lastly, while the program had an independent government cost estimate conducted in 2007, it only provided an independent assessment of the prime contractor's proposal, and not the program's full life-cycle cost estimate. In addition, as previously mentioned, CLASS has experienced cost, schedule, and scope changes since 2007, and an independent cost estimate has not been conducted since.

Source: GAO analysis of the CLASS program's cost estimate.

## Patents End-to-End: Software Engineering

### Investment Details

Department of Commerce (United States Patent and Trademark Office)

Program start date: 2010

Full operational capability:

- Current: 2013
- Original: 2013

Total life-cycle cost:

- Current: \$188.2 million
- Original: \$130.2 million

Current life-cycle phase: Development

Source: Agency data.

The Patents End-to-End: Software Engineering (PE2E-SE) program is designed to provide a fully electronic patent application process. According to the U.S. Patent and Trademark Office, the agency's current enterprise architecture is unable to meet current demands, and it has relied on inefficient and outdated automated legacy systems that inhibit the timely examination of patent applications. PE2E-SE intends to provide an electronic filing and processing application that enables examiners to meet current needs for the timely examination of patents. To accomplish this, PE2E-SE is following an Agile<sup>2</sup> development approach and intends to implement a system using a text-based eXtensible Markup Language standard that is flexible, scalable, and leverages modern technologies with open standards. In fiscal year 2012, the program plans to build new functionality, such as new text search tools, and deploy the system to a limited set of examiners.

In 2010, PE2E-SE developed an initial cost estimate of \$130.2 million. This estimate only included costs for development, over a 3-year life cycle. Subsequently, in 2012 and after multiple revisions, PE2E-SE revised its cost estimate to \$188.2 million, an increase of \$58.0 million. This includes \$122.8 million for development and \$65.4 million for operations and maintenance over a 7-year life cycle. According to program officials, these changes are primarily due to incorporating costs for operations and maintenance into the estimate.

The PE2E-SE program's current cost estimate does not exhibit all of the qualities of a reliable cost estimate. Specifically, while the estimate partially reflects key practices for developing a comprehensive, well-documented, and accurate estimate, it does not reflect key practices for developing a credible estimate. Table 9 provides details on our assessment of the PE2E-SE program's cost estimate.

<sup>2</sup>Agile software development is not a set of tools or a single methodology, but a philosophy based on selected values, such as prioritizing customer satisfaction through early and continuous delivery of valuable software; delivering working software frequently, from every couple of weeks to every couple of months; and making working software the primary measure of progress. For more information on Agile software development, see <http://www.agilealliance.org>.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 9: Assessment of the PE2E-SE Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The estimate includes government and contractor costs over most of the program's life cycle (e.g., design, development, and deployment) and completely defines the program and reflects the current schedule. Further, the estimate includes cost-influencing ground rules and assumptions, such as the types of technology to be used, and monitors the validity of these assumptions over time. However, the estimate does not include all costs associated with operations and maintenance (e.g., to provide for at least one hardware and software technical refresh beyond the end of development) and does not include costs associated with system retirement. Further, detailed estimates are structured by function instead of being product-oriented, which makes it difficult to plan and track costs by deliverables. As a result, the program will not be able to identify which deliverables, such as a hardware or software component, are causing cost or schedule overruns.
Well-documented	Partially met	The program documented a technical baseline description that provides the technical, programmatic, and schedule basis for the estimate and documented review and approval of all aspects of the estimate, including estimates for program subcomponents (i.e., smaller projects within PE2E-SE lasting less than a year). Further, the documentation captures high-level source data, from the Patent and Trademark Office's previous failed effort to modernize the patent examining process, on which the estimate is based. However, detailed data to support estimates for program subcomponents are not captured, and the program also did not document the methodologies followed or the detailed calculations performed in completing the estimate. As a result, an analyst unfamiliar with the program would be unable to understand and use the program's cost estimate, and the estimate is less useful for information-sharing and updating.
Accurate	Partially met	The estimate is updated with actual costs to reflect current program status. Further, at a high level, the estimate is based on historical cost data from the office's previous failed effort to modernize the patent examining process, although estimates for program subcomponents are based primarily on team expertise. By using more historical data to support detailed estimates, or data from comparable programs, PE2E-SE could more effectively challenge optimistic assumptions and bring more realism to the cost estimate. Without more supporting data, however, and without conducting a risk and uncertainty analysis to determine where the estimate fell against the range of all possible costs, the PE2E-SE program cannot be assured that the estimate represents the most likely costs to be incurred. Lastly, the estimate was not adjusted for inflation. Adjusting for inflation is important because cost data must be expressed in consistent terms, or cost overruns can result.
Credible	Not met	Within the estimate, cost drivers were not cross-checked to see if different estimating methodologies produced similar results. Further, a risk and uncertainty analysis was not conducted to quantify the impact of risks to the estimate. While officials stated that some contingency funding is included, without conducting a risk and uncertainty analysis the program cannot be assured that adequate reserves exist to address contingencies that may arise. Additionally, a sensitivity analysis was not conducted to better understand which variables most affect the cost estimate. Lastly, no steps were taken—such as an independent cost estimate—to independently validate the results of the program's estimate. An independent estimate is considered one of the most reliable methods for validating the estimate and increases the likelihood that management will have confidence in the credibility of the program's cost estimate. As a result of these weaknesses, the program does not have an understanding of the limitations associated with the estimate and cannot know whether its estimate is realistic.

Source: GAO analysis of the PE2E-SE program's cost estimate.

## Consolidated Afloat Networks and Enterprise Services

### Investment Details

Department of Defense (Department of the Navy)

Program start date: 2008

Full operational capability:

- Current: 2023
- Original: 2016

Total life-cycle cost:

- Current: \$12.741 billion
- Original: \$12.741 billion

Current life-cycle phase: Development

Source: Agency data.

The Consolidated Afloat Networks and Enterprise Services (CANES) program is designed to consolidate and standardize the Department of the Navy's existing network infrastructures and services. According to the department, the current network infrastructure is highly segmented and includes several legacy environments that have created inefficiencies in the management and support of shipboard networks. The CANES program is intended to, among other things, reduce and eliminate existing standalone afloat networks, provide a technology platform that can rapidly adjust to changing warfighting requirements, and reduce the shipboard hardware footprint. To accomplish this, the program will rely primarily on commercial off-the-shelf software integrated with network infrastructure hardware components. The CANES program is currently planning to procure and conduct preinstallation activities of four limited fielding units by the end of fiscal year 2012, and achieve full operational capability in 2023.

In 2010, the Navy's Space and Naval Warfare Systems Command Cost Analysis Division developed a program life-cycle cost estimate for the CANES program, and the Naval Center for Cost Analysis developed an independent cost estimate. Subsequently, these organizations worked collaboratively to develop the program's life-cycle cost estimate of approximately \$12.7 billion. This included approximately \$4.0 billion for development and approximately \$8.8 billion for operations and maintenance over a 23-year life cycle.

The CANES program's cost estimate exhibits all of the qualities of a reliable cost estimate. Specifically, the estimate reflects key practices for developing a comprehensive, well-documented, accurate, and credible estimate. Table 10 provides details on our assessment of the CANES program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 10: Assessment of the CANES Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Fully met	The estimate includes both the government and contractor costs specific to design, development, deployment, operation and maintenance, and retirement of the program. Moreover, the cost estimate reflects the current program and technical parameters, such as the acquisition strategy and physical characteristics of the system. <sup>a</sup> In addition, the estimate clearly describes how the various cost subelements are summed to produce the amounts for each cost category, thereby ensuring that all pertinent costs are included, and no costs are double counted. Lastly, cost-influencing ground rules and assumptions, such as the program's schedule, labor rates, and inflation rates are documented.
Well-documented	Fully met	The estimate captured in writing the source data used (e.g., historical data and program documentation), the calculations performed and their results, and the estimating methodology used to derive each cost element. The cost estimate is also well documented in that a technical baseline has been documented that includes, among other things, the relationships with other systems and planned performance parameters. Also, the cost estimate was reviewed both by the Naval Center for Cost Analysis and the Assistant Secretary of the Navy for Research, Development, and Acquisition, which ensures a level of confidence in the estimating process and the estimate produced.
Accurate	Fully met	The cost estimate is based on an assessment of most likely costs. More specifically, a risk and uncertainty analysis was performed that determined that the estimate is at the 53 percent confidence level—meaning that there is a 53 percent chance that the estimate will be met. Using this information, management can more proactively monitor the program's costs and better prepare contingencies to monitor and mitigate risks. In addition, the estimate was grounded in historical costs and actual experiences from other comparable programs, including the five legacy systems that CANES is intended to replace. Lastly, the estimate was adjusted for inflation—for example, the cost estimate is presented in both base-year dollars (with the effects of inflation removed) as well as then-year dollars (with inflation included).
Credible	Fully met	The CANES program performed a complete uncertainty analysis (i.e., both a sensitivity analysis and Monte Carlo simulation <sup>b</sup> ) on the estimate. More specifically, a sensitivity analysis was conducted that identified a range of possible costs based on varying key parameters, such as the technology refresh cycle and procurement costs. A risk and uncertainty analysis was also conducted using a Monte Carlo simulation that identified the distribution of total possible costs and the confidence level (53 percent) associated with the cost estimate. As a result, decision makers are more informed of program cost, schedule, and technical risks and can better prepare mitigation strategies. Lastly, an independent cost estimate was conducted by the Naval Center for Cost Analysis and the results were reconciled with the CANES program's cost estimate. Because an independent cost estimate is considered one of the best and most reliable methods for validating an estimate, management can have increased confidence in the credibility of the resulting estimate.

Source: GAO analysis of the CANES program's cost estimate.

<sup>a</sup>The number of ships that the CANES system will be deployed to recently changed from 193 ships to 175 ships due to the decommissioning of certain ships earlier than anticipated. While the cost estimate does not fully reflect the current ship deployment schedule, the program continually monitors the deployment schedule, tracks changes between the deployment schedule and the cost estimate, and is in the process of updating the estimate for an upcoming milestone review. Therefore, we determined that the program adequately met the intent of this best practice.

<sup>b</sup>A Monte Carlo simulation assesses the aggregate variability of the cost estimate to determine a confidence range around the cost estimate.



## Tactical Mission Command

### Investment Details

Department of Defense (Department of the Army)

Program start date: 2005

Full operational capability:

- Current: 2016
- Original: 2018

Total life-cycle cost:

- Current: \$2.692 billion
- Original: \$1.969 billion

Current life-cycle phase: Mixed (development/operations and maintenance)

Source: Agency data.

The Tactical Mission Command (TMC)<sup>3</sup> is designed to be the tactical battle command system for commanders and staffs from battalions through the Army Service Component Commands. TMC is intended to provide commanders and staff with improved battle command capabilities, including increasing the speed and quality of command decisions. In the near term, TMC is to address gaps in the Army's tactical battle command capability by delivering enhanced collaborative tools and enterprise services, and, in the long term, TMC is to address rapid improvements in technological capabilities through technology refresh. A key component—known as the Command Post of the Future—is intended to provide commanders and key staff with an executive-level decision support capability enhanced with real-time collaborative tools. These capabilities are expected to enhance situational awareness and support an execution-focused battle command process. Currently, the program is working to complete development of Command Post of the Future 7.0, which the program plans to complete by the end of fiscal year 2012.

In 2008, the TMC program developed an initial cost estimate of approximately \$2.0 billion. This included approximately \$1.9 billion for development and \$116.5 million for maintenance over a 14-year life cycle. According to program officials, each subsequent year, in preparation for the annual Weapons System Review, the program updated its life-cycle cost estimate. In 2011 the TMC program established its current cost estimate of approximately \$2.7 billion, an increase of approximately \$723 million over its initial cost estimate. This included approximately \$2.0 billion for development and \$650.7 million for operations and maintenance over a 23-year life cycle. Program officials stated that the increase in the estimate was due, in part, to changes in the life-cycle time frames, fielding schedules, number of units planned for deployment, and other software development changes.

The TMC program's current cost estimate does not exhibit all qualities of a reliable cost estimate. Specifically, while the estimate partially reflects key practices for developing a comprehensive, well-documented, and accurate estimate, it does not reflect key practices for developing a credible estimate. Table 11 provides details on our assessment of TMC program's cost estimate.

<sup>3</sup>According to the program's fiscal year 2013 budget submission documentation, this investment is also referred to as the Maneuver Control System.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 11: Assessment of the TMC Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The estimate includes both the government and contractor costs specific to design, development, deployment, and operation and maintenance over the program's 23-year life cycle. Further, the estimate is based on a cost element structure that is at an appropriate level of detail, in that it includes multiple levels of cost subelements that are summed to produce the totals for each cost category. However, while the program documented the system's requirements in 2006, it cannot be determined whether the cost estimate fully reflects the current program and schedule. Specifically, officials stated that, in preparation for the program's annual Weapon System Review process, the cost estimate was updated to reflect changes to the 2006 requirements and the system deployment schedule; however, the program did not provide sufficient evidence showing these changes and how they impacted the estimate. Further, while the cost element structure is at an appropriate level of detail, this structure does not map to the program's work breakdown structure used for the day-to-day management of the program. Without consistency in these structures, the program cannot track estimated against realized costs. Lastly, the program documented certain cost-influencing assumptions (e.g., inflation indexes and base-year dollars used); however, it did not identify other important assumptions, such as cost limitations (e.g., unstable funding stream or staff constraints) and system quantities.
Well-documented	Partially met	The cost estimate documentation captures the calculations performed and their results, and the methodologies used to derive certain cost elements. For example, the program's cost-estimating software tool contains a series of input variables, such as the number of active Army units, used to calculate certain hardware and software costs for the program. However, the software tool does not include the data sources, methodologies, or calculations for several important cost elements, such as those associated with development and software maintenance and assurance fees. Program officials stated that costs associated with these elements are estimated in spreadsheets outside of the cost-estimating tool; however, the tool does not identify the specific spreadsheet associated with these cost elements or the data sources used to project those costs. As a result, the cost estimate is not captured in a way that can be easily updated and replicated. In addition, as previously mentioned, the program documented the system's requirements in 2006; however, it has not adequately documented changes to these requirements and their impact on the cost estimate. Lastly, the program did not provide evidence that the current cost estimate had been approved by senior management.
Accurate	Partially met	The program provided supporting documentation showing that the estimate accounted for inflation and was grounded in historical data from the program. For example, in calculating software-related costs during deployment of the system, the program relied on software costs from fiscal years 2009 and 2010, along with the anticipated fielding schedule, to project costs for future years. However, the program did not provide evidence that the estimate had been regularly updated. While program officials stated that the estimate is updated every 6 months based on a prioritized set of requirements as defined by the logistics team and other technical experts, the program did not provide evidence that this process is occurring. Lastly, the estimate does not reflect an assessment of most likely costs. More specifically, a risk and uncertainty analysis was not conducted to determine where the estimate fell against the range of all possible costs, and to identify the most likely estimate.
Credible	Not met	The program did not perform a sensitivity analysis nor a risk and uncertainty analysis. According to TMC program officials, "what if" drills were performed to assess the cost impact of potential changes to the program, such as a requirement to deploy 20 additional units per year. However, these drills do not gauge the sensitivity of program assumptions to identify a range of possible costs. Further, a risk and uncertainty analysis was not performed to assess the variability in the cost estimate so that a level of confidence could be determined. According to officials, there are currently no high risks in developing the system's software. However, without actually taking steps to understand the limitations associated with the estimate, the program cannot have confidence that this is actually the case. In addition, the program did not perform cross-checks on key cost drivers using different estimating methodologies to see if the results were similar. Lastly, an independent cost estimate was not conducted by a group outside of the acquiring organization to validate the program's cost estimate.

Source: GAO analysis of the TMC program's cost estimate.

## Financial System Modernization Project

### Investment Details

Environmental Protection Agency (Office of the Chief Financial Officer)

Program start date: 2002

Full operational capability:

- Current: 2011
- Original: 2008

Total life-cycle cost:

- Current: \$169.3 million
- Original: \$163.2 million

Current life-cycle phase: Operations and maintenance

Source: Agency data.

The Financial System Modernization Project (FSMP) replaced the Environmental Protection Agency's legacy core financial system. The system is intended to address agency-identified shortcomings in its previous financial systems, such as inconsistent data, limited system interoperability, low system usability, and costly maintenance. FSMP includes key functionality for performing cost and project management, general ledger, payment management, and receivables management. According to the agency, the system is intended to, among other things, eliminate repetitive data entry, integrate legacy systems, and enable agency staff to manage workflow among the Office of the Chief Financial Officer and between other business lines (e.g., acquisitions and grants management). The system was deployed in October 2011.

In 2005, the FSMP program developed an initial cost estimate of approximately \$163.2 million. This included \$42.8 million for development and \$120.4 million for operations and maintenance over a 25-year life cycle. After revising the cost estimate three times, in 2010 the program established its current cost estimate of approximately \$169.3 million, an increase of approximately \$6 million over its initial cost estimate. This includes \$103.7 million for development and \$65.7 million for operations and maintenance over a 15-year life cycle. Program officials stated that the changes to the program's life-cycle cost estimate are due, in part, to changes in the Environmental Protection Agency's policies and guidance, such as using a 15-year program life cycle instead of the 25-year life cycle used in the program's original estimate. In addition, officials stated that the FSMP program has undergone significant schedule and scope changes, including delaying the system's deployment date from 2008 to 2011 and reducing in the planned system components (e.g., budget formulation)—all of which have impacted the program's life-cycle cost estimate.

The FSMP program's current cost estimate does not exhibit all qualities of a reliable cost estimate. Specifically, while the estimate partially reflects key practices for developing a comprehensive, well-documented, and accurate estimate, it does not reflect key practices for developing a credible estimate. Table 12 provides details on our assessment of FSMP program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 12: Assessment of the FSMP Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The estimate includes government and contractor costs of the program over most of its life cycle (e.g., design, development, and deployment). Further, the estimate is documented at an appropriate level of detail in that it includes multiple levels of cost subelements that are summed to produce the totals for each cost category. In addition, the estimate reflects the program's high-level schedule milestones, such as reaching full operational capability in 2011. However, the estimate does not include costs associated with the retirement of the program. In addition, it cannot be determined if the estimate completely defines the program because key documents, such as the Concept of Operations, have not been updated and program officials stated that hundreds of documents exist capturing the changing specifications of the system since they were determined in 2005. Further, while the estimate is based on documented assumptions from 2009, these assumptions have not been updated to account for material changes in the program that have occurred since then, including changes to the program's schedule, planned system components, and training requirements.
Well-documented	Partially met	The program's documentation describes, at a summary level, the estimating methodologies used to derive major cost elements and the data sources used, such as subject matter experts and issued task orders. In addition, the cost estimate was reviewed and approved by management as part of the program's July 2010 rebaseline effort. However, the cost estimate documentation lacks important details about the source data, such as the specific subject matter experts involved, circumstances affecting the data, and whether the data have been adjusted for inflation. Moreover, the data used to derive the estimate cannot easily be traced back to, and verified against, their sources so that the estimate can be easily replicated and updated. For example, there are differences in the costs estimates and their supporting task orders, and those differences, including the specific circumstances affecting the task orders, are not well documented. Lastly, while the estimate was approved, management was not briefed on how the estimate was developed, including enough detail to show whether it is accurate, complete, and high in quality.
Accurate	Partially met	The estimate was regularly updated based on actual costs from the program, and to reflect material changes. More specifically, the program established an initial cost estimate in 2005, which it later updated in 2008, 2009, and 2010, to reflect significant changes to the program's scope and schedule, among other things. In addition, the estimate accounted for inflation in certain cost elements, such as operations and maintenance. However, the estimate was not grounded in a historical record of cost estimating and actual experiences on other comparable programs. For example, while the program did assess the scope, requirements, and software solutions selected on the financial systems modernization projects at other federal agencies, the review did not look at the costs associated with these systems and subsequently use that information in developing the FSMP cost estimate. In addition, because a risk and uncertainty analysis has not been performed, the program did not determine where the estimate fell against the range of all possible costs and thus cannot be assured that the estimate represents the most likely costs to be incurred.
Credible	Not met	The FSMP program did not perform a sensitivity analysis or a risk and uncertainty analysis on the cost estimate. Because uncertainty cannot be avoided, it is necessary to identify the cost elements that represent the most risk. A sensitivity analysis reveals how the cost estimate is affected by a change in a single assumption, which helps the cost estimator understand which variables most affect the cost estimate. Moreover, a risk and uncertainty analysis can assess the variability in the cost estimate so that a level of confidence can be given about the estimate. In addition, cross-checks were not performed on major cost elements using different estimating methodologies to see if the results were similar. When cross-checks demonstrate that alternative methods produce similar results, then confidence in the estimate increases, leading to greater credibility. Lastly, while the program had an independent government cost estimate conducted in 2005, it only provided an independent assessment of the prime contractor's proposal, and not the program's full life-cycle cost estimate. In addition, since 2005, the program has experienced cost, schedule, and scope changes, and an independent cost estimate has not been conducted since.

Source: GAO analysis of the FSMP program's cost estimate.

## Superfund Enterprise Management System

### Investment Details

Environmental Protection Agency (Office of Solid Waste and Emergency Response)

Program start date: Fiscal year 2007

Full operational capability:

- Current: 2013
- Original: 2013

Total life-cycle cost:

- Current: \$62.0 million
- Original: \$39.3 million

Current life-cycle phase: Mixed (development/operations and maintenance)

Source: Agency data.

The Superfund Enterprise Management System (SEMS) is to replace three legacy systems and multiple applications used to comply with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980<sup>4</sup>—commonly known as Superfund, which provides federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. In addition, SEMS is designed to implement innovative software tools that will allow for more efficient operation of the Superfund program. Of the three legacy systems expected to be replaced by SEMS, two have already been integrated, and the one remaining system is expected to be fully integrated in 2013, at which time SEMS is planned to achieve full operational capability.

In 2009, the SEMS program developed an initial cost estimate of approximately \$39.3 million. This included \$20.8 million for development, \$14.7 million for operations and maintenance, and \$3.8 million for government personnel costs over a 10-year life cycle. Subsequently, in 2011, the program revised its estimate to approximately \$62.0 million, an increase of about \$22.7 million over its initial cost estimate. This includes \$22.8 million for development and \$39.2 million for operations and maintenance over a 10-year life cycle. Program officials stated that the increase in the estimate was primarily due to incorporating additional operations and maintenance costs that were erroneously omitted from the initial estimate.

The SEMS program's current cost estimate does not exhibit all qualities of a reliable cost estimate. Specifically, while the estimate partially reflects key practices for developing a credible estimate, it does not reflect key practices for developing a comprehensive, well-documented, or accurate estimate. Table 13 provides details on our assessment of SEMS program's cost estimate.

<sup>4</sup>42 U.S.C. § 9604.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 13: Assessment of the SEMS Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Not met	While the estimate included government and contractor costs for certain phases of the program's life cycle, such as planning and development of the system, it did not include at least 10 years of operations and maintenance costs beyond the program's planned deployment in 2013. According to program officials, only 4 years of operations and maintenance costs were included because agency guidance only requires program costs to be estimated through 2017. Moreover, it cannot be determined whether the estimate defines the program and reflects the current schedule because it is not supported by detailed documentation (see the assessment of well-documented below). This is due, in part, to the lack of a cost element structure at a sufficient level of detail. Such a structure would provide assurance that cost elements are neither omitted nor double counted, as well as provide improved traceability to the program's scope. Lastly, no cost-influencing ground rules and assumptions (e.g., labor rates and base-year dollars) were documented. Documenting all assumptions is imperative to ensuring that management fully understands the conditions under which the estimate was structured.
Well-documented	Not met	The documentation of the estimate only includes the resulting cost estimates and does not capture in writing the source data used, the calculations performed and their results, and the estimating methodology used to derive each cost element. As a result, the estimate is not captured in such a way that it can be easily replicated and updated. Further, while the program has documented certain information about the system's technical baseline, such as physical characteristics of the system and planned interfaces with other systems, it cannot be determined whether the technical baseline is consistent with the cost estimate because the supporting details of the cost estimate are not documented. Lastly, while the high-level estimate was reviewed and approved by management, management was not briefed on how the estimate was developed, which is needed to convey a level of confidence in the estimating process and the estimate produced by the process.
Accurate	Not met	The estimate relied largely on expert opinion as the basis of the cost estimate and did not use historical costs and actual experiences from comparable programs. While SEMS program officials stated that they relied on cost data from three legacy systems to estimate costs for operating and maintaining SEMS, the program did not have supporting documentation showing how the data were used. In addition, because a risk and uncertainty analysis has not been performed, the SEMS program did not determine where the estimate fell against the range of all possible costs, and cannot be assured that the estimate represents the most likely costs to be incurred. Further, while limited operations and maintenance costs were adjusted for inflation, the cost estimate documentation did not include information regarding the source or rationale of the inflation factors used. Lastly, while the cost estimate has been previously updated, it cannot be determined whether the estimate reflects current status information because the program has not adequately documented detailed supporting information of the cost estimate.
Credible	Partially met	The SEMS program had a cost-benefit analysis completed in September 2010 by a group outside of the program office to validate the SEMS cost estimate, which yielded a cost estimate within 1 percent of the SEMS program's cost estimate. Because an independent estimate is considered one of the most reliable methods for validating the estimate, management can have increased confidence in the credibility of the program's cost estimate. However, the program did not perform a sensitivity analysis or a risk and uncertainty analysis on the SEMS cost estimate. Because uncertainty cannot be avoided, it is necessary to identify the cost elements that represent the most risk. A sensitivity analysis reveals how the cost estimate is affected by a change in a single assumption, which helps the cost estimator understand which variables most affect the cost estimate. Further, a risk and uncertainty analysis can assess the variability in the cost estimate from such effects as schedule slippage and proposed solutions not meeting user needs. Lastly, cross-checks were not performed on major cost elements using different estimating methodologies to see if the results were similar. When cross-checks demonstrate that alternative methods produce similar results, then confidence in the estimate increases, leading to greater credibility.

Source: GAO analysis of the SEMS program's cost estimate.

## Integrated Public Alert and Warning System

### Investment Details

Department of Homeland Security (Federal Emergency Management Agency)

Program start date: 2004

Full operational capability:

- Current: 2017
- Original: 2018

Total life-cycle cost:

- Current: \$311.4 million
- Original: \$259 million

Current life-cycle phase: Mixed (development/operations and maintenance)

Source: Agency data.

The Integrated Public Alert and Warning System (IPAWS) is designed to provide a reliable, integrated, and comprehensive system to alert and warn the American people before, during, and after disasters. To accomplish this, the program is developing the capability to disseminate national alerts to cellular phones and expanding the existing Emergency Alert System to cover 90 percent of the American public. In 2011, IPAWS established standards for alert messages, began cellular carrier testing, and conducted a nationwide test of the expanded Emergency Alert System capabilities. The program intends to deploy the cellular alerting capability nationwide in 2012 and complete its expansion of the Emergency Alert System in 2017.

In 2009, IPAWS developed its initial estimate of \$259 million, which included \$252.1 million for development and \$6.9 million for government personnel costs, but did not include operations and maintenance costs. In 2011, the program revised its estimate to \$311.4 million, an increase of about \$52.3 million. This includes \$268.9 million for development and \$42.5 million for operations and maintenance over an 11-year life cycle. According to program officials, the increase in the cost estimate is primarily due to the inclusion of costs to operate and maintain the system during development.

The IPAWS program's current cost estimate does not exhibit all qualities of a reliable cost estimate. Specifically, while the estimate fully reflects key practices for developing an accurate estimate, it only partially reflects key practices for developing a comprehensive, well-documented, and credible estimate. Table 14 provides details on our assessment of IPAWS program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 14: Assessment of the IPAWS Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The estimate includes government and contractor costs over most of the program's life cycle (e.g., design, development, and deployment); is supported by a technical baseline which provides the technical, programmatic, and schedule basis for the estimate; uses a detailed cost element structure to ensure that no cost elements are omitted or double-counted; and identifies cost-influencing ground rules and assumptions, such as inflation indices and government furnished equipment. However, the estimate does not include any operations and maintenance costs beyond the end of development in 2017 (to provide for at least one hardware and software technical refresh cycle) and does not include costs associated with system retirement. Furthermore, while the estimate uses a detailed cost element structure, the structure is not product-oriented, which would allow costs to be planned and tracked by work products. Without a product-oriented structure, the program will not be able to identify which deliverables, such as a hardware or software component, are causing cost or schedule overruns.
Well-documented	Partially met	The program documented a high-level mapping of cost elements to data sources and estimating methodologies, but the supporting detailed cost model is not aligned with this mapping and does not clearly relate data sources to specific calculations, identify estimating methodologies, or describe calculations step-by-step. As a result, an analyst unfamiliar with the program would find it difficult to understand and use the program's estimate and supporting cost model, making the estimate less useful for information sharing or updating. Additionally, while the program provided evidence that management reviewed and approved the estimate, key information about the estimate was not provided to management. For example, management was briefed on the estimate and technical- and risk-related information, but this briefing did not include the confidence level associated with the point estimate.
Accurate	Fully met <sup>a</sup>	The program relied on historical program costs and data from comparable programs in preparing and updating the estimate. For example, the program used data from a legacy disaster management system in estimating costs for part of its system deployment. Further, because the program relied on historical costs, and conducted a risk and uncertainty analysis to determine where the estimate fell against the range of all possible costs, the program has increased assurance that the estimate reflects the most likely costs to be incurred. Additionally, the estimate is properly adjusted for inflation—for example, the cost estimate is presented in both base-year dollars (with the effects of inflation removed) as well as then-year dollars (with inflation included). Lastly, program officials regularly update the estimate with actual costs so that it reflects the current program.
Credible	Partially met	The program conducted a sensitivity analysis to identify the cost drivers that most impacted the estimate and a risk and uncertainty analysis to determine where the estimate fell against the range of possible costs. However, despite this analysis showing the cost estimate having less than a 50 percent chance of being achieved, no contingency reserve was identified. Officials stated that conservative assumptions in the analysis provide an informal risk reserve, and that if a significant risk was realized it would be an agency decision about how to fund a response. However, best practices state that contingency funding should be a risk-based decision because, often, it can take many months to receive additional funding to address an emerging program issue. Further, the program did not cross-check key cost drivers, which would show whether different estimating methodologies produced similar results, and an independent cost estimate was not conducted to validate the estimated costs. Without taking these steps, the program lacks a full understanding of the limitations in the estimate and may not be prepared to deal with unexpected contingencies.

Source: GAO analysis the IPAWS program's cost estimate.

<sup>a</sup>The IPAWS estimate met all key practices for an accurate cost estimate. While the estimate is not fully comprehensive, well-documented, or credible, in this case, the weaknesses in those areas do not preclude the estimate from meeting key practices representative of an accurate cost estimate.



## Rescue 21

### Investment Details

Department of Homeland Security (U.S. Coast Guard)

Program start date: 1997

Full operational capability:

- Current: 2017
- Original: 2006

Total life-cycle cost:

- Current: \$2.662 billion
- Original: \$250 million<sup>a</sup>

Current life-cycle phase: Mixed (deployment/operations and maintenance)

Source: Agency data.

<sup>a</sup>The Rescue 21 program's original cost estimate, developed in 1999, only included system acquisition costs and did not include costs for operating and maintaining the system. These costs were subsequently included in the program's 2005 revisions to the cost estimate.

Rescue 21 is designed to modernize the U.S. Coast Guard's maritime search and rescue capability. According to the agency, the current system—the National Distress and Response System, does not meet the demands of the 21st century in that it does not provide complete coverage of the continental United States, cannot receive distress calls during certain transmissions, lacks interoperability with other government agencies, and is supported by outdated equipment. Rescue 21 is intended to provide a modernized maritime distress and response communications system, with increased maritime homeland security capabilities that encompass coastlines, navigable rivers, and waterways in the continental United States, in addition to Hawaii, Guam, and Puerto Rico. Rescue 21 is currently undergoing regional deployment, which is planned to be completed in fiscal year 2017.

In 1999, the Rescue 21 program developed an initial cost estimate of \$250 million for acquisition of the system, but this estimate did not include any costs for operations and maintenance of the system. Following three rebaselines, in 2006 the Rescue 21 program revised the estimate to \$1.44 billion, an increase of approximately \$1.19 billion over the initial estimate. This included \$730 million in development and \$707 million in operations and maintenance over a 16-year life cycle. According to program documentation, these increases were due, in part, to incorporating costs for the operation and maintenance of the system. Subsequently, in 2008, the Rescue 21 program revised its cost estimate again to \$2.66 billion, an increase of approximately \$1.22 billion over the previous estimate, and approximately \$2.41 billion over the initial cost estimate. This includes \$1.07 billion in development and \$1.59 billion in operations and maintenance over a 16-year life cycle. Program officials stated that the most recent increase in the cost estimate was primarily due to schedule delays, an extension of the program's life cycle by 6 years based on an expected increase in the system's useful life, and to reflect more realistic estimates of future costs for ongoing system technology refreshment.

The Rescue 21 program's current cost estimate does not exhibit all qualities of a reliable cost estimate. Specifically, the estimate partially reflects key practices for developing a comprehensive, well-documented, accurate, and credible estimate. Table 15 provides details on our assessment of the Rescue 21 program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 15: Assessment of the Rescue 21 Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The cost estimate includes all government and contractor costs of the program over its full life cycle (e.g., development, operations and maintenance, and disposal) and documents cost-influencing ground rules and assumptions (e.g., budget constraints and inflation rates). Moreover, the cost estimate defines key program and technical parameters, such as the acquisition strategy, physical characteristics of the system, and relationships with predecessor systems. However, the estimate does not reflect the current schedule in that the deployment dates for several locations of the system have been delayed, but the estimate has not yet been updated. According to officials, the program is in the process of updating the estimate to reflect these changes, and it should be completed in fiscal year 2012. Further, while the program defined cost elements at an appropriate level of detail, the work breakdown structure was not product-oriented.
Well-documented	Partially met	The cost-estimate documentation captures in writing the source data used, calculations performed and their results, and methodologies used to derive each of the cost elements. In addition, the cost estimate was reviewed and approved by management, and included key information regarding the Rescue 21 program's technical and program baseline, such as the completion date for full production. However, the program's estimate is from 2008 and has not been updated to reflect changes to the technical baseline of the program, such as additional deployment sites needed to address service gaps identified by local commanders at previously deployed locations. Moreover, while the estimate was reviewed and approved, management did not receive all of the information necessary to make an informed decision. More specifically, a risk and uncertainty analysis was performed that found that, on the range of all possible costs, the program's cost estimate fell at the 12 percent confidence level—meaning that there is an 88 percent chance of a cost overrun. However, this confidence level was not identified or provided as part of the estimate's review and approval, which calls into question whether management had all the information needed to make an informed decision.
Accurate	Partially met	The estimate accounted for inflation based on Office of Management and Budget guidance. In addition, the estimates for utilities, leases, and environmental permitting, among other things, were grounded in historical costs and actual experiences. Further, the estimate has been regularly updated from 1999 through 2008 to account for changes in the program. However, the program cost estimate was not based on an assessment of most likely costs. More specifically, as previously mentioned, a cost uncertainty analysis was performed that determined that the estimate is at the 12 percent confidence level—meaning that there is a 88 percent chance of a cost overrun. Accepting such a confidence level means that the program has accepted an overly optimistic cost estimate rather than reflecting the most likely cost of the program. In addition, while the estimate has been updated in the past, the current estimate, dated January 2008, does not fully reflect the current status of the program. Specifically, as previously mentioned, the estimate does not reflect the current deployment schedule and, according to program officials, will also need to be updated to reflect increased contractor costs and updated time frames for system sustainment.
Credible	Partially met	The Rescue 21 program performed a complete uncertainty analysis (i.e., both a sensitivity analysis and Monte Carlo simulation) on the estimate. More specifically, a sensitivity analysis was conducted that identified a range of possible costs based on varying key parameters, such as the technology refresh cycle and change control costs. A risk and uncertainty analysis was also conducted using a Monte Carlo simulation that identified the distribution of total possible costs and the confidence level (12 percent) associated with the cost estimate. As a result, the program is more informed of cost, schedule, and technical risks and can better prepare mitigation strategies. However, cross-checks were not performed on major cost elements using different estimating methodologies to see if the results were similar. Further, an independent cost estimate was not conducted by a group outside of the acquiring organization to validate the program's cost estimate.

Source: GAO analysis of the Rescue 21 program's cost estimate.

## Next Generation Combined DNA Index System

### Investment Details

Department of Justice (Federal Bureau of Investigation)

Program start date: 2006

Full operational capability:

- Current: 2011
- Original: 2012

Total life-cycle cost:

- Current: \$137.0 million
- Original: \$128.4 million

Current life-cycle phase: Operations and maintenance

Source: Agency data.

Since 1998, the Combined DNA Index System (CODIS) has supported the Federal Bureau of Investigation's mission by assisting criminal investigation and surveillance through DNA collection and examination capabilities. CODIS is an automated DNA information processing and telecommunications system that generates potential investigative leads in cases where biological evidence is recovered. Among other things, CODIS links crime scene evidence to other crimes and/or offenders, which can identify serial offenders and/or potential suspects. CODIS serves over 190 participating laboratories and 73 international laboratories representing 38 countries. According to the Federal Bureau of Investigation, the reliability and expandability of CODIS are critical to the agency's ability to effectively aid law enforcement investigations through the use of biometrics, prompting the decision in 2006 to initiate a modernization effort, referred to as Next Generation CODIS (NGCODIS). In 2011, the program achieved full operational capability for CODIS 7.0, a software release of NGCODIS, which included functionality for, among other things, implementing a software solution to comply with European Union legislation for DNA data exchange and maintaining DNA records of arrested persons. Additional functionality is expected in the future; however, all program development has been put on hold until the necessary funding is approved.

In 2006, the CODIS program developed an initial cost estimate for NGCODIS of \$128.4 million. This included approximately \$69.6 million for development and \$58.8 million for operations and maintenance over an 11-year life cycle. In 2009, the CODIS program developed an additional cost estimate of \$58.6 million to account for operations costs associated with certain versions of NGCODIS. According to program officials, even though the program estimated additional operations costs of \$58.6 million, the program's original cost estimate has increased by only \$8.6 million because originally planned development work related to incorporating advancements in DNA technology was delayed and the costs associated with this work were removed from the cost estimate.

The CODIS program's current cost estimate for NGCODIS does not exhibit all qualities of a reliable cost estimate. Specifically, the estimate partially reflects key practices for developing a comprehensive, well-documented, accurate, and credible estimate. Table 16 provides details on our assessment of the NGCODIS cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 16: Assessment of the NGCODIS Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The estimate includes both the government and contractor costs specific to design, development, deployment, operation and maintenance, and disposal of the system. Further, the estimate is documented at an appropriate level of detail in that it includes multiple levels of cost subelements that are summed to produce the totals for each cost category. In addition, the estimate includes documented cost-influencing ground rules and assumptions (e.g., labor rates and inflation rates). However, while the estimate generally reflects the program's technical baseline, such as the acquisition plan and key performance parameters, this information is contained in multiple documents (instead of a single document). As a result, it may be difficult for the program to update the estimate and provide a verifiable trace to the new cost baseline as assumptions change during the course of the program's life cycle. In addition, while the estimate uses a detailed cost element structure, the structure is not product oriented, which would allow costs to be planned and tracked by work products. Without a product-oriented structure, the program may not be able to identify which deliverables, such as a hardware or software component, are causing cost or schedule overruns.
Well-documented	Partially met	The cost estimate documentation captures in writing most of the source data used, calculations performed, and methodologies used, and the estimate was reviewed and approved by management. In addition, as previously mentioned, the cost estimate documentation generally reflects the current technical characteristics of the program, such as the key performance parameters. However, the cost estimate documentation did not always describe the source data and methodologies used to estimate costs for certain aspects of the program. For example, the estimate includes the number of projected staff associated with the Support Contractor; however, there is no explanation for where these projections came from. Further, although the cost estimate was reviewed and approved by a Federal Bureau of Investigation Executive Steering Council, the information presented to management did not include adequate detail, such as information about how the estimate was developed and the risks associated with the underlying data and methods. Without such information, management cannot have confidence in the estimating process or the estimate produced by the process.
Accurate	Partially met	The estimate accounted for inflation and has been updated in the past to reflect material changes to the program, such as the inclusion of new requirements for interacting with international DNA repositories. Further, the program projected operations and maintenance costs based on its experience with prior version of CODIS. In addition, the program used a cost-estimating software tool in projecting software development costs that program officials stated relied upon cost data from thousands of programs. However, the estimate only partially reflected an assessment of most likely costs. More specifically, while the program provided the results of its risk and uncertainty analysis and the most likely cost estimate, it did not provide evidence supporting how it performed the analysis and determined the range of all possible costs. Therefore, it cannot be determined what confidence levels may have been used or the degree of uncertainty given all of the risks considered.
Credible	Partially met	The program provided a range of potential costs based on the level of risk facing the program and also provided information describing these risks. For example, the program identified the finalization of the system requirements and changes to the assumptions behind the cost model as two primary areas that drive the uncertainty of the cost estimate. In addition, the program conducted a sensitivity analysis for assumptions associated with the development of NGCODIS. Specifically, the program altered a series of input factors within the cost-estimating software tool used in order to test the sensitivity of the program's development costs based on each factor. However, although the program adjusted the development costs based on program risk factors built into the estimating tool, the program office did not provide evidence to explain which factors were adjusted, why those factors were adjusted, or determine the confidence level associated with the final cost estimate. Further, the sensitivity analysis performed only addressed costs associated with system development, and did not include an assessment of the sensitivity of assumptions associated with other aspects of the program, such as operations and maintenance of the system. Lastly, an independent cost estimate was not conducted by a group outside of the acquiring organization to validate the program's cost estimate.

Source: GAO analysis of the NGCODIS cost estimates.

## Unified Financial Management System

### Investment Details

Department of Justice (Justice Management Division)

Program start date: 2002

Full operational capability:

- Current: 2014
- Original: 2010

Total life-cycle cost:

- Current: \$851.1 million
- Original: \$357.2 million

Current life-cycle phase: Mixed (development/operations and maintenance)

Source: Agency data.

The Unified Financial Management System (UFMS) is to modernize the Department of Justice's financial management and procurement operations. To accomplish this, UFMS is to replace four legacy core accounting systems and multiple procurement systems with a commercial off-the-shelf product. Ultimately, the system is expected to streamline and standardize financial management and procurement processes and procedures across the department's component agencies. UFMS was deployed to two component agencies—the Drug Enforcement Administration and the Bureau of Alcohol, Tobacco, Firearms, and Explosives—in fiscal years 2009 and 2011, respectively. The system is planned to be deployed at other component agencies, including the U.S. Marshals Service and the Federal Bureau of Investigation, between fiscal years 2013 and 2014, and is expected to achieve full operational capability in fiscal year 2014.

In 2002, the UFMS program developed an initial cost estimate of \$357.2 million. This included approximately \$196.4 million for development and \$160.8 million for maintenance over a 10-year life cycle. In 2009, the UFMS program revised the estimate to \$1.05 billion, an increase of approximately \$692.8 million. This included \$469.5 million for development and \$581.6 million for operations and maintenance over a 20-year life cycle. Program officials stated that the increase in the estimate was due to extending the program's life cycle to include additional years of development work and operations and maintenance of the system. Subsequently, in 2011, the program revised its cost estimate to \$851.1 million, a decrease of approximately \$198.9 million. This estimate includes \$419.5 million for development and \$431.6 million for operations and maintenance over a 20-year life cycle. Program officials stated that the decrease in the cost estimate was due to a reduction in the number of component agencies that planned to implement UFMS. Specifically, UFMS removed the Federal Bureau of Prisons; Offices, Boards and Divisions; and Office of Justice Programs from the system's deployment schedule in order to reduce the overall cost of the system.

The UFMS program's current cost estimate does not exhibit all qualities of a reliable cost estimate. Specifically, while the estimate partially reflects key practices for developing a comprehensive, well-documented, and accurate estimate, it does not reflect key practices for developing a credible estimate. Table 17 provides details on our assessment of UFMS program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 17: Assessment of the UFMS Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The cost estimate includes government and contractor costs of the program over most of its life cycle, including costs associated with design, development, and deployment of the system. In addition, the cost estimate defines costs at an appropriate level of detail. For example, the program relies on a cost element structure that is decomposed to three levels and describes the work to be performed. Further, the cost estimate documents cost-influencing ground rules and assumptions such as labor and inflation rates. However, the cost estimate does not account for all program costs, in that it excludes costs for retirement of the system and certain costs incurred by component agencies to implement the system. According to program officials, certain component agency implementation costs, such as the costs for help desk support, are not included because these costs are funded separately through the component agencies. However, according to best practices, a life-cycle cost estimate should encompass all past, present, and future costs for every aspect of the program, regardless of funding source. In addition, the estimate lacks important details needed to determine if it completely defines the current program. Specifically, in 2010, UFMS rescoped the program by removing planned component agency implementations and reducing the cost estimate from \$1.05 billion to \$851.5 million, a reduction of about \$198.9 million, but did not update the cost estimate documentation to justify the associated change in cost. Finally, while the cost element structure used is at an appropriate level of detail, it does not align with the work breakdown structure being used to manage the current work activities to be completed by the program.
Well-documented	Partially met	The cost estimate documentation captures in writing most of the source data used, calculations performed and their results, and methodologies used to derive each of the cost elements, and was reviewed and approved by management. However, the cost estimate documentation only supports the program as defined in 2009 and has not been updated to reflect significant changes to the program that occurred as part of the 2010 rescoping effort. According to the UFMS Program Manager, the cost estimate documentation does not reflect the current program because the life-cycle cost estimate is considered a static document that is used as a basis for funding and budget requests, and is not planned to be updated. In addition, the estimating methodology and associated calculations are excluded for some of the work.
Accurate	Partially met	The estimate accounted for inflation based on Office of Management and Budget guidance. In addition, the estimate was grounded in a historical record of actual experiences in that the program leveraged cost data from a prior implementation of the system. More specifically, in projecting system implementation costs at other Department of Justice component agencies, the program relied on historical data from the implementation of the UFMS system at the Department of Justice's Drug Enforcement Agency and applied scaling factors to estimate the implementation costs of the system at other component agencies. However, the estimate does not reflect an assessment of the most likely costs. More specifically, the program did not determine where the estimate fell against the range of all possible costs. In addition, the estimate has not been regularly updated to reflect material changes, such as the 2010 rescoping of the program.
Credible	Not met	The estimate is not credible because a risk and uncertainty analysis and sensitivity analysis specific to the estimate were not performed. A risk and uncertainty analysis can be used to assess variability in the overall cost estimate, while a sensitivity analysis can reveal how the cost estimate is affected by a change in a single assumption, which helps the cost estimator understand which variables most affect the cost estimate. The UFMS Program Manager stated that such analyses were not conducted, in part, because the labor costs are fixed, and blanket purchase agreements allowed for the UFMS team to extrapolate cost data for future years, therefore reducing the program's exposure to risk. However, without actually taking steps to understand the limitations associated with the estimate, the program cannot have confidence that this is actually the case. Further, cross-checks were not performed on major cost elements using different estimating methodologies to see if the results were similar. Lastly, an independent cost estimate was not conducted by a group outside of the acquiring organization to validate the program's cost estimate, which further calls into question the estimate's credibility.

Source: GAO analysis of the UFMS program's cost estimate.

## OSHA Information System

### Investment Details

Department of Labor (Occupational Safety and Health Administration)

Program start date: 2005

Full operational capability:

- Current: 2011
- Original: 2009

Total life-cycle cost:

- Current: \$91.3 million
- Original: \$72.3 million

Current life-cycle phase: Operations and maintenance

Source: Agency data.

The OSHA Information System (OIS) is a management tool consisting of a suite of applications to reduce workplace fatalities, injuries, and illnesses through enforcement, compliance assistance, and consultation. According to the agency, OIS is intended to close performance gaps with existing legacy systems resulting from irreplaceable legacy hardware and software, the inability of legacy systems to fully support the agency's mission, and the absence of an application that supports key business process areas, such as compliance assistance. Ultimately, OIS is expected to provide a centralized web-based solution to be used by more than 5,900 users at the federal and state level, including approximately 4,200 enforcement officers and 500 safety and health consultants. The program completed development in 2011, and is working to complete deployment of the system while addressing operations and maintenance of the system, which the program plans to complete by the end of fiscal year 2016.

In 2006, the OIS program developed an initial cost of \$72.3 million. This included \$42.0 million for development and \$30.3 million for operations and maintenance over a 12-year life cycle. Subsequently, in 2010, the OIS program revised its cost estimate to \$91.3 million, an increase of \$19.0 million. This includes \$63.3 million for development and approximately \$28.0 million for operations and maintenance over a 12-year life cycle. The OIS Program Manager stated that the increase in the estimate was due, in part, to unanticipated changes to the OIS program's scope to better align with the Department of Labor's strategic goals, including securing safe and healthy workplaces, particularly in high-risk industries. For example, according to this official, the agency's methodology for penalty calculations for violators of occupational safety and health rules and regulations was modified, which required a redesign of OIS in order to capture and accurately calculate these changes.

The OIS program's current cost estimate does not exhibit all qualities of a reliable cost estimate. Specifically, while the estimate partially reflects key practices for developing a comprehensive, well-documented, and accurate estimate, it does not reflect key practices for developing a credible estimate. Table 19 provides details on our assessment of the OIS program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 18: Assessment of the OIS Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The cost estimate includes government and contractor costs of the program over most of its life cycle, including planning, acquisition, and certain operations and maintenance costs. The estimate also includes cost-influencing ground rules and assumptions, such as user staffing levels and hardware-hosting responsibilities. However, the cost estimate does not account for all applicable program life-cycle costs, including at least 10 years of operations and maintenance costs beyond the program's deployment date in 2011. A program official stated that the OIS program will consider including the costs associated with additional years of operation and maintenance in a future update to the estimate. In addition, the current cost estimate is not structured at a sufficient level of detail. Specifically, while OIS program officials stated that the program's 2010 estimate is primarily supported by the program's 2005 cost model, the cost elements in these two estimates are inconsistent.
Well-documented	Partially met	The cost estimate documentation partially captures in writing the source data used, calculations performed and their results, and the estimating methodologies used to derive the cost elements. However, the supporting cost model documentation reflects the program as defined in 2005 and has not been updated to reflect the program's current \$91.3 million cost estimate. More specifically, in 2010, the estimated costs of the program increased approximately \$12 million; however, the program did not update its 2005 cost model or document the supporting details for this increase. Further, the program did not provide documentation that the cost estimate was submitted to, or approved by, management. According to program officials, the estimate was approved as part of the budget process, during which the cost estimate was reviewed and approved by both OSHA management and the Department of Labor's Office of the Assistant Secretary for Administration and Management and the Office of the Chief Information Officer; however, this review and approval was not documented.
Accurate	Partially met	The program relied on a contractor with access to historical data in developing the estimate and associated cost model. According to program officials, in 2005, the program hired a consulting firm based on its cost-estimating expertise and historical cost data repository. Further, at that time, the program stated that it used an estimating method in projecting software development costs that drew upon data from thousands of programs based on specific data points entered by the program. In addition, while the program updated its cost estimate in 2010 to reflect changes to the program and actual costs incurred since 2005, significant changes to the program have occurred since 2010 that have not been included in the cost estimate. For example, the 2010 cost estimate accounts for operations and maintenance costs at approximately \$26.7 million; however, an operations and maintenance contract was recently awarded for approximately \$39.9 million, an increase of about \$13 million, which has not been accounted for in the cost estimate. According to program officials, the cost estimate is currently being updated; however, a completion date for this effort has not yet been determined. Further, the estimate is not based on an assessment of the most likely costs. Specifically, because a risk and uncertainty analysis has not been performed to determine where the estimate fell against the range of all possible costs, the OIS program cannot determine if the estimate represents the most likely costs to be incurred.
Credible	Not met	The OIS program provided a set of risk-adjusted figures but could not provide evidence supporting those figures for the most recent cost estimate. According to program officials, the program used the Department of Labor's cost-benefit analysis tool which takes risks identified by the program and adjusts projected program costs based on underlying formulas embedded in the tool. However, officials could only provide evidence that this was used in a 2008 update to the cost estimate. In addition, while the program conducted 'what if' drills by varying the overall estimate to determine at what point it would be necessary to choose a different acquisition approach, it did not conduct a comprehensive sensitivity analysis that identified key program cost drivers and determined a range of possible costs by varying major assumptions and parameters. Further, cross-checks were not performed on major cost elements using different estimating methodologies to see if the results were similar, which further calls into question the estimate's credibility. Lastly, no steps were taken—such as an independent cost estimate—to independently validate the results of the program's estimate.

Source: GAO analysis of the OIS program cost estimate.



## PBGC Benefit Administration

### Investment Details

Department of Labor (Pension Benefit Guaranty Corporation<sup>3</sup>)

Program start date: 2007

Full operational capability:

- Current: 2017
- Original: 2017

Total life-cycle cost:

- Current: \$155.9 million
- Original: \$186.9 million

Current life-cycle phase: Mixed (development/operations and maintenance)

Source: Agency data.

<sup>3</sup>Although not a component of the Department of Labor, for administrative purposes, the Pension Benefit Guaranty Corporation is included within the department's budget submission documentation.

The Pension Benefit Guaranty Corporation's (PBGC) Benefit Administration (BA) is a collection of IT systems and applications that allows PBGC to administer and service the approximately 1.5 million participants in over 4,300 plans that have been terminated and trustee as part of PBGC's insurance program for single-employer pensions. The BA program is intended to modernize and consolidate applications, retire legacy systems, and address performance gaps. To do this, the BA program is grouped into four projects—Customer Care, Document Management, Case Management, and Benefit Management—in support of paying accurate and timely payments and providing customer service to participants. The BA program is expected to offer multiple self-service channels to participants, reengineer benefit payment processes to increase efficiency and productivity, and implement enhanced reporting and document management systems. According to the agency, this modernization effort is ultimately expected to increase customer satisfaction, reduce operational costs, and improve data quality. Currently, the program is scheduled to complete modernization and decommission the remaining legacy applications in fiscal year 2015.

In 2007, the BA program developed an initial cost estimate of \$186.9 million. This included \$39.4 million for development and \$147.5 million for operations and maintenance over a 5-year life cycle. Subsequently, in 2010, BA revised its cost estimate to \$155.9 million, a decrease of \$31.0 million. This revised estimate includes \$80.7 million for development and approximately \$75.2 million for operations and maintenance over a 10-year life cycle. Program officials stated that the decrease in the estimate was due to changes to the program's schedule milestones and changes to the system's architecture.

The BA program's current cost estimate does not exhibit all qualities of a reliable cost estimate. Specifically, the estimate partially reflects key practices for developing a comprehensive, well-documented, accurate, and credible estimate. Table 18 provides details on our assessment of the BA program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 19: Assessment of the BA Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The cost estimate includes most contractor costs of the program over its life cycle, including planning, development, and operations and maintenance of the system. In addition, the cost estimate includes documented ground rules and assumptions, such as the assumed hourly contractor rate and the period of performance for the system. However, the cost estimate is not fully comprehensive because it does not account for all applicable program costs in that it excludes costs associated with government personnel and retirement of the system. According to program officials, costs that did not impact the acquisition strategy, as well as costs incurred by the program prior to 2010, were excluded. However, according to best practices, a life-cycle cost estimate should encompass all past, present, and future costs for every aspect of the program. In addition, estimated costs were assigned to high-level categories such as contractor development and testing/change management; however, the cost element structure is not at a sufficient level of detail or aligned with the program's work breakdown structure.
Well-documented	Partially met	The cost estimate was reviewed and approved by the BA Program Manager and presented to the Information Technology Investment Review Board and Executive Management Committee. In addition, the program's cost estimate documentation describes, at a summary level, the types of source data and estimating methodologies used. For example, according to the cost estimate documentation, the program derived costs from past operations and maintenance costs, management support costs, vendor cost data, team subject matter experts, and current contracts. However, the specific source data, calculations and results, and methodologies used to estimate each cost element are not well documented and do not track to the final cost estimate. More specifically, in developing the cost estimate, the program relied on multiple project teams to develop the cost estimates specific to their areas of expertise. However, the source data, calculations and results, and methodologies used to determine these individual project cost estimates were not always documented and, in many cases, did not track between the project worksheets and the final cost estimate.
Accurate	Partially met	The cost estimate accounted for inflation based on Office of Management and Budget guidance. In addition, the cost estimate was updated in 2010 to account for changes to the program that had occurred since it was initiated in 2007. However, it cannot be determined whether the estimate fully reflects the current status information because the program has not adequately documented detailed supporting information of the cost estimate (see the assessment of well-documented above). Lastly, program officials stated that the cost estimate is based on, among other things, historical operations and maintenance costs and management support costs. However, the program's supporting documentation did not provide evidence that these data were used. Further, the estimate is not based on an assessment of the most likely costs because the program did not perform a comprehensive risk and uncertainty analysis to determine where the estimate fell against the range of all possible costs, and to identify the most likely estimate.
Credible	Partially met	The cost estimate included risk-adjusted figures. Specifically, program officials stated that brainstorming sessions were held during which the program relied on Office of Management and Budget risk categories to identify risks, and then adjusted the program's cost estimate to account for these risks. Further, officials stated that risks are continuously monitored for their potential impact on the program. However, the program did not provide supporting documentation for how the program arrived at the risk-adjusted cost figures in the cost estimate, nor evidence that a quantitative risk and uncertainty analysis was performed to assess the aggregate variability of the cost estimate to determine a confidence range around the estimate. The program also performed a sensitivity analysis for three scenarios. Specifically, the program assessed the potential impact of higher-than-anticipated contractor labor rates, a reduced life cycle for the program, and a change in the acquisition strategy. However, the scenarios did not provide a basis for the changes to the selected assumptions or a minimum and maximum range for the adjustments. Lastly, no steps were taken—such as an independent cost estimate—to independently validate the results of the program's estimate, and cross-checks were not performed on major cost elements using different estimating methodologies.

Source: GAO analysis of the BA program's cost estimate.

## Health Data Repository

### Investment Details

Department of Veterans Affairs (Office of Information and Technology)

Program start date: 2001

Full operational capability:

- Current: 2017
- Original: 2006

Total life-cycle cost:

- Current: \$491.5 million
- Original: \$126.7 million

Current life-cycle phase: Mixed (development/operations and maintenance)

Source: Agency data.

The Health Data Repository (HDR) is intended to support the integration of clinical data across the Department of Veterans Affairs and with external healthcare systems such as that of the Department of Defense. Specifically, the system is designed to provide a nationally accessible repository of clinical data by accessing and making available data from existing healthcare systems to support clinical and nonclinical decision-making for the care of the department's patients. The system is being developed using an Agile software development approach and, currently, the program is working on software releases to improve the ability to access data in VA's legacy healthcare information system, and intends to achieve full operating capability in 2017.

In 2001, the HDR program developed an initial cost estimate of \$126.7 million. This included \$105.9 million for development and \$20.8 million for operations and maintenance over a 7-year life cycle. According to officials, the program revised its estimate each year during the budget cycle; in 2011, HDR revised its cost estimate to \$491.5 million, an increase of approximately \$364.8 million over its initial cost estimate. This includes \$281.9 million for development and \$209.6 million for operations and maintenance over a 17-year life cycle. Program officials stated that the increase in the cost estimate was primarily due to the unplanned deployment and operation of a prototype system for 5 years, and the delay of the planned date for full operational capability from 2006 to 2017, in part, because of changes in the program's scope and technology refreshes (i.e., equipment and storage capacity).

The HDR program's current cost estimate does not exhibit any of the qualities of a reliable cost estimate. Specifically, the estimate does not reflect key practices for developing a comprehensive, well-documented, accurate, and credible estimate. Table 20 provides details on our assessment of HDR program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 20: Assessment of the HDR Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Not met	The estimate does not include sufficient detail to show that costs for all life-cycle phases (e.g., design, development, and deployment) are fully accounted for. In addition, the estimate does not include operations and maintenance costs beyond the completion of system development work, or costs associated with retirement of the system. Further, the estimate does not contain technical baseline information to define the technical, program, and schedule aspects of the system being estimated. Additionally, the estimate only uses high-level budget codes rather than a detailed, product-oriented cost element structure to decompose the work. Without a cost element structure at sufficient detail, the program will lack assurance that cost elements are neither omitted nor double counted. Lastly, ground rules and assumptions (e.g., labor rates and base-year dollars) are not documented. As a result of these weaknesses, the estimate is unlikely to include all program costs, and is likely understated.
Well-documented	Not met	The HDR program did not support the estimate with adequate technical baseline documentation, which would provide a technical, programmatic, and schedule description of the program. Further, the program did not document the data sources, calculations and their results, or the methodologies used in developing the estimate, so an analyst unfamiliar with the program would not be able to use or replicate the estimate. Additionally, the documentation does not provide evidence that management has reviewed and approved the program's total estimated costs of \$491.5 million because the information presented to management only includes costs of project increments, the most recent of which only had estimated costs of about \$39 million, and did not include adequate details, such as information about how the estimate was developed. Because a cost estimate is not considered valid until management has approved it, it is imperative that management understand how the estimate was developed, including risks associated with underlying data and methods. Without sufficient documentation, management and oversight organizations will not be convinced that the estimate is credible, and questions about the approach or data used to create the estimate cannot be answered.
Accurate	Not met	The estimate is updated each year as part of the budget cycle, but the program lacks assurance that the cost estimate accurately reflects current program status due to, as described above, the lack of a comprehensive schedule and technical baseline. Further, the estimate is not based on historical costs or actual experiences from comparable programs. Such data can be used to challenge optimistic assumptions and bring more realism to the estimate. Additionally, the estimate was not properly adjusted for inflation. Adjusting for inflation is important because cost data must be expressed in consistent terms, or cost overruns can result. Lastly, the estimate is not based on an assessment of most likely costs, because the program did not rely on historical data and did not conduct a risk and uncertainty analysis to determine where the estimate fell against the range of all possible costs. As a result, decision makers cannot have confidence that the estimate accurately represents the program's full life-cycle cost.
Credible	Not met	Key cost drivers were not cross-checked using different methodologies to see if the results were similar, which can be used to increase confidence in the estimates. Further, while a previous cost estimate developed by the program was adjusted for risk, a comprehensive risk and uncertainty analysis was not conducted for the current estimate to quantify the impact of risks and identify a confidence level associated with the estimate. While officials stated that some contingency funding is included, without conducting a risk and uncertainty analysis, the program cannot be assured that adequate reserves exist to address contingencies that may arise. Additionally, a sensitivity analysis was not conducted to better understand which variables most affect the cost estimate. Lastly, no steps were taken—such as an independent cost estimate—to independently validate the results of the program's estimate. As a result of these weaknesses, the program does not have an understanding of the limitations associated with the estimate and cannot know whether its estimate is realistic.

Source: GAO analysis of the HDR program's cost estimate.

## Veterans Benefits Management System

### Investment Details

Department of Defense (Department of the Navy)

Program start date: 2008

Full operational capability:

- Current: 2023
- Original: 2016

Total life-cycle cost:

- Current: \$12.741 billion
- Original: \$12.741 billion

Current life-cycle phase: Development

Source: Agency data.

The Veterans Benefits Management System (VBMS) is intended to provide a paperless claims processing system to support processing a growing volume of claims—for example, the number of compensation and pension claims submitted in a year passed 1 million for the first time in 2009. According to the department, due to the reliance on paper-based processing, the current system is inefficient and costly, and carries risks to veterans' sensitive information. To address this, VBMS is designed to provide veterans a secure and accessible means to obtain benefits, reduce the claims backlog, implement standardized business practices, and support the integration with other veteran-facing systems. The program is currently developing functionality for compensation and pension claims processing, and plans to add additional lines of business in future years.

In 2008, the VBMS program developed an initial, high-level cost estimate of \$560.0 million for system development over a 5-year life cycle, which did not include costs for operations and maintenance. Subsequently, after revising the estimate each year as part the program's Office of Management and Budget Exhibit 300 submission, in 2011 VBMS revised its cost estimate to \$934.8 million, an increase of approximately \$374.8 million over its initial estimate. This includes \$433.7 million for development and \$501.1 million for operations and maintenance over an 11-year life cycle. Program officials stated that the increase in the estimate was primarily due to incorporating costs associated with operations and maintenance and effort spent on changing to an Agile development approach.

The VBMS program's current cost estimate does not exhibit all of the qualities of a reliable cost estimate. Specifically, while the estimate partially reflects key practices for developing a comprehensive and well-documented estimate, it does not reflect key practices for developing an accurate and credible estimate. Table 21 provides details on our assessment of the VBMS program's cost estimate.

**Appendix II: Case Studies of Selected Programs' Cost-Estimating Practices**

**Table 21: Assessment of the VBMS Program's Cost Estimate**

<b>Characteristic</b>	<b>Assessment</b>	<b>Key examples of rationale for assessment</b>
Comprehensive	Partially met	The estimate includes government and contractor costs over limited phases of the program's life cycle, such as initiation and development. However, the estimate does not include operations and maintenance costs beyond the end of development (to provide for at least one software and hardware technical refresh cycle) and does not include costs associated with system retirement. Further, the estimate is supported by technical baseline information contained in the program's Business Requirements Document, which provides the technical, schedule, and programmatic basis for the estimate, but some of this information is out of date. For example, the technical baseline only describes work through 2013, while the estimate describes work to be completed through 2017. Further, the estimate lacks sufficient detail to ensure that cost elements are neither omitted nor double-counted. Lastly, the estimate does not include cost-influencing ground rules and assumptions (e.g., labor rates or base-year dollars). Documenting all assumptions is imperative to ensuring that management fully understands the conditions under which the estimate was developed. Without a fully comprehensive cost estimate, decision makers cannot be assured of having a complete view of program costs.
Well-documented	Partially met	The program documented certain aspects of the system's technical baseline, but, as described above, this information is out of date. Further, while the program described limited use of source data and documented certain calculations in estimates for near-term acquisition costs, the documentation does not capture all the data sources or the methodologies used in developing the estimate. As a result, an analyst unfamiliar with the program would find it difficult to use or replicate the estimate. Lastly, the documentation provides evidence that management approved the estimate; however, this was not done on the basis of confidence in the estimating process because management was not provided sufficient information about how the estimate was developed and the risks associated with the underlying data and methods. Without sufficient documentation, management and oversight organizations will not be convinced that the estimate is credible and the estimate is not useful for updates or information sharing.
Accurate	Not met	The program lacks assurance that the cost estimate accurately reflects current program status due to, as described above, the lack of a comprehensive schedule and technical baseline. Further, although officials described limited use of historical cost data, the program did not have supporting documentation showing how the data were used. Such data can be used to challenge optimistic assumptions and bring more realism to the estimate. Additionally, the estimate was not adjusted for inflation. Adjusting for inflation is important because cost data must be expressed in consistent terms, or cost overruns can result. Lastly, the estimate is not based on an assessment of most likely costs, because the program did not rely on good source data and did not conduct a risk and uncertainty analysis to determine where the estimate fell against the range of all possible costs, and the most likely costs. As a result, decision makers cannot have confidence that the estimate accurately represents the program's full life-cycle cost.
Credible	Not met	A risk and uncertainty analysis was not conducted to quantify the impact of risks to the estimate. While officials stated that some informal contingency funding is included to address risks, without conducting a risk and uncertainty analysis the program cannot be assured that adequate reserves exist to address contingencies that may arise. Further, a sensitivity analysis was not conducted to better understand which variables most affect the cost estimate. In addition, cost drivers were not cross-checked to see if different estimating methodologies produced similar results. Lastly, program officials stated that efforts to validate the results of the program's cost estimate with an independent cost estimate are in process and planned to be completed in May 2012. Until these gaps are addressed, the program will not have a full understanding of the limitations associated with the estimate and cannot know whether its estimate is realistic.

Source: GAO analysis of the VBMS program's cost estimate.

# Appendix III: Original and Current Life-Cycle Cost Estimates for Case Study Programs

Collectively, 13 of the 16 case study programs have revised their cost estimates upward by almost \$5 billion. More specifically, the 13 programs have experienced cost increases ranging from about \$6 million to over \$2 billion. For example, in many cases, cost estimates had to be revised upwards to reflect the incorporation of full costs for all life-cycle phases (e.g. development or operations and maintenance), which had not originally been included. Other reasons that programs cited for revising their life-cycle cost estimates upward included changes to program or system requirements, schedule delays, technology upgrades, and system defects, among other things. Among the remaining 3 programs, 1 program's cost estimate had decreased, 1 had not changed, and 1 was not applicable because the program only had a current cost estimate (see table 22).

**Table 22: Original and Current Life-Cycle Cost Estimates for Case Study Programs (as of April 2012)**

Dollars in millions

Agency	Program	Original life-cycle cost estimate	Current life-cycle cost estimate	Change in cost	Percentage Change
Agriculture	Public Health Information System	n/a <sup>a</sup>	\$82.3 <sup>a</sup>	n/a	n/a
	Web-Based Supply Chain Management	\$142.9	\$378.4	\$235.5	165%
Commerce	Comprehensive Large Array-data Stewardship System	\$195.5	\$240.0	\$44.5	23%
	Patents End-to-End: Software Engineering	\$130.2	\$188.2	\$58.0	45%
Defense	Consolidated Afloat Networks and Enterprise Services	\$12,740.9	\$12,740.9	\$0	0%
	Tactical Mission Command	\$1,968.9	\$2,691.5	\$722.6	37%
Environmental Protection Agency	Financial System Modernization Project	\$163.2	\$169.3	\$6.1	4%
	Superfund Enterprise Management System	\$39.3	\$62.1	\$22.8	58%
Homeland Security	Integrated Public Alert and Warning System	\$259.0	\$311.4	\$52.4	20%
	Rescue 21	\$250.0 <sup>b</sup>	\$2,662.0	\$2,412.0	965%
Justice	Next Generation Combined DNA Index System	\$128.4	\$137.0	\$8.6	7%
	Unified Financial Management System	\$357.2	\$851.1	\$493.9	138%
Labor	OSHA <sup>c</sup> Information System	\$72.3	\$91.3	\$19.0	26%
	PBGC <sup>d</sup> Benefit Administration	\$186.9	\$155.9	\$(31.0)	(17)%
Veterans Affairs	Health Data Repository	\$126.7	\$491.5	\$364.8	288%
	Veterans Benefits Management System	\$560.0 <sup>e</sup>	\$934.8	\$374.8	67%
<b>Total</b>		<b>\$17,321.4</b>	<b>\$22,105.4</b>	<b>\$4,784.0</b>	

Source: GAO analysis of program data.

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**Appendix III: Original and Current Life-Cycle  
Cost Estimates for Case Study Programs**

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<sup>a</sup>The Public Health Information System was originally part of the Public Health Information Consolidation Projects investment and, therefore, did not have a life-cycle cost estimate at the time of origination. The program's current life-cycle cost estimate has been excluded from the total.

<sup>b</sup>The Rescue 21 program's original cost estimate, developed in 1999, only included system acquisition costs and did not include costs for operating and maintaining the system. These costs were subsequently included in the program's 2005 revisions to the cost estimate.

<sup>c</sup>Occupational Safety and Health Administration.

<sup>d</sup>Pension Benefit Guaranty Corporation. PBGC is a wholly owned government corporation administered by a presidentially appointed, Senate-confirmed Director and overseen by a Board of Directors consisting of the Secretaries of Labor, the Treasury, and Commerce. Although not a component of the Department of Labor, for administrative purposes, PBGC is included within the department's budget submission documentation. Therefore, PBGC's IT investments (including Benefit Administration) were included among the Department of Labor's IT investments in the Office of Management and Budget Fiscal Year 2010 Exhibit 53, which provided the basis for our selection of the 16 case study programs.

<sup>e</sup>The Veterans Benefits Management System program's original cost estimate, developed in 2008, only included system development costs and did not include costs for operating and maintaining the system. These costs were included in subsequent revisions to the cost estimate.



# Appendix IV: Comments from the Department of Agriculture

United States  
Department of  
Agriculture



Office of the Chief  
Information Officer

1400 Independence  
Avenue S.W.

Washington, DC  
20250

Valarie C. Melvin  
Director  
Information Technology Team  
U.S. Government Accountability Office  
441 G Street, N. W.  
Washington, DC 20548

JUN 20 2012


Dear Ms. Melvin:

The U.S. Department of Agriculture has reviewed the draft report GAO Draft Report (IT Cost Estimation) - GAO-12-629 (Job Code: 311245), July 2012.

Thank you for the opportunity to respond to the GAO draft report. We Concur with the content of the report and have no comments.

For additional information, please contact Denice Lotson, Office of the Chief Information Officer Audit Liaison, at 202-720-9384.

Sincerely,

  
Cheryl L. Cook  
Acting Chief Information Officer

AN EQUAL OPPORTUNITY EMPLOYER

# Appendix V: Comments from the Department of Commerce



**UNITED STATES DEPARTMENT OF COMMERCE**  
**The Secretary of Commerce**  
Washington, D.C. 20230

June 22, 2012

Ms. Valerie C. Melvin  
Director, Information Management  
and Technology Resources Issues  
U.S. Government Accountability Office  
441 G Street NW  
Washington, DC 20548

Dear Ms. Melvin:

Thank you for the opportunity to comment on the draft report from the U.S. Government Accountability Office (GAO) entitled *Information Technology Cost Estimation: Agencies Need To Address Significant Weaknesses in Policies and Practices* (GAO-12-629).

We recognize several of the cost estimating shortfalls in the Department of Commerce (DOC). Since a Secretarial-directed Acquisition Improvement Study in 2010 to investigate issues contributing to problems in several high profile acquisitions, the Department has made great strides over the course of the last year to implement corrective actions to address several issues. The results of the study identified the need for a more comprehensive and corporate approach for overseeing and managing acquisitions, particularly with regard to requirements development, cost estimating, and the acquisition project management processes.

A follow-on Department-wide Acquisition Improvement Project (AIP) was aimed at creating the approaches and infrastructure to sustain a healthy acquisition system, with special emphasis on high profile projects that merit Department-level oversight. The AIP developed the Scalable Acquisition Project Management Framework (the Framework) for use in managing future acquisition projects (Information Technology (IT) and non-IT). An interim acquisition framework policy has been drafted and should be issued shortly, after finalizing the last set of Bureau inputs. The DOC Office of Inspector General (OIG) has likewise cited the need for the Department to develop a high-profile systems acquisition policy and has recognized this in its OIG FY13 Top Management Challenges.

We fully concur with the report's findings and recommendations to modify Departmental policies governing cost estimating and have been actively engaged in many of the actions. Specifically, we are addressing each of the seven policy area weaknesses (for both IT and non-IT programs) as follows.

- Clear Requirement for Cost Estimating: As part of the DOC newly developed acquisition framework policy and guidance, there are clear processes and documentation required for project cost estimates and Independent Cost Estimates (ICE) at the various Framework milestones.
- Compliance with Cost-Estimating Best Practices: The final acquisition framework policy anticipated by the end of 2012 will be accompanied by specific cost estimating guidance referencing *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP. We will ensure that high-profile program and project estimates (those overseen by DOC headquarters) are comprehensive, accurate, credible, and well documented.
- Management Review and Approval: The proposed DOC milestone review process includes an Integrated Product Team (IPT) approach to review the corresponding milestone materials in advance of and to inform each milestone decision meeting. The IPT will ensure rigorous compliance with the framework, to review materials for the adequacy, and to raise any unreconciled issues at each milestone decision meeting for final arbitration and resolution. The review of each program's cost estimate will include content, cost, schedule, and risk assessments.
- Training Requirements: We are developing an on-line cost estimating course which will be fully completed in September 2012 to address specific DOC cost estimating requirements, but is applicable across multiple government agencies. The Department has been working on identifying its full community of practice of Program/Project Managers (P/PM), to include non-IT and subordinate P/PMs in high-profile programs. Once the community is identified, mandatory training requirements for cost estimating will include this course.
- Central, Independent Cost Estimating Team: The Office of Acquisition Management (OAM) which has been leading the effort in developing the acquisition framework has also brought in senior federal staff experts to assist programs and bureaus to succeed in program and project management, systems engineering, and cost estimating. Recent examples of projects benefiting OAM's involvement and leadership are the National Telecommunications and Information Administration's Federal Spectrum Management System as well as the National Oceanic and Atmospheric Administration's (NOAA) Geostationary Operational Environmental Satellite-R Series (GOES-R) program and their Fisheries Survey Vessel 6 (FSV6).
- Standard Structure for Defining Work Products: In developing its acquisition framework, the Department has leveraged policies throughout the federal government and the private sector to construct an acquisition process tailored to the DOC requirements, capabilities, and program variety. The same premise is also being applied to the standard templates and the work breakdown structures to be used. Our intent is to leverage Military Standard 881, National Aeronautics and Space Administration, and commodity-specific products as we find them, recognizing their need to be tailored as circumstances warrant.
- Process to Collect and Store Cost-Related Data: As programs progress through the acquisition process, data will be collected on a variety of program types. This has already begun. For example, historical flight and ground segment costs have been collected and cataloged for the

GOES-R program and will similarly be completed for the Joint Polar Satellite System. In addition, analogous data are being collected and cataloged from outside the Department for comparison across the cost community. For example, cost estimates for NOAA's FSV6 are being compared with historical, analogous DoD and Coast Guard development costs. Also we are collecting case study projects to populate and refine the cost estimating course. We also plan to use cost data identified by the US Patent and Trademark Office as they are made available to us.

With regard to the specific DOC IT investment programs evaluated by GAO, Comprehensive Large Array-data Stewardship System (CLASS) and Patents End-to-End (PE2E), we concur with the report's findings and will ensure that the future cost estimates for these programs follow GAO's cost estimating best practices to correct the weaknesses identified. Our forthcoming acquisition framework policy and guidance will also include the appropriate elements to ensure that cost estimates for high-profile programs are comprehensive, accurate, credible, and well-documented.

Please contact Barry Berkowitz at 202-482-4248, if you have questions regarding this response.

Sincerely,



Rebecca M. Blank  
Acting Secretary of Commerce

# Appendix VI: Comments from the Department of Defense



COST ASSESSMENT AND  
PROGRAM EVALUATION

OFFICE OF THE SECRETARY OF DEFENSE  
1800 DEFENSE PENTAGON  
WASHINGTON, D.C. 20301-1800

JUN 26 2012

Ms. Valerie Melvin  
Director, Information Management and Technology Resources Issues  
U.S. Government Accountability Office  
441 G Street, NW  
Washington, DC 20548

Dear Ms. Melvin,

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) draft report GAO-12-629, "INFORMATION TECHNOLOGY COST ESTIMATION: Agencies Need to Address Significant Weaknesses in Policies and Practices", dated May 22, 2012, (GAO Code 311245). The Department partially concurs with the recommendation addressed to DoD. The Department's full response to the report's recommendation is attached.

The Department appreciates the opportunity to respond to your draft report. Should you have any questions please contact my primary action officer, Mr. William E. Raines, at 571-256-1426 or [william.raines@osd.mil](mailto:william.raines@osd.mil).

Sincerely,

Christine H. Fox  
Director

Attachment(s):

1. DoD Comments to GAO Recommendations

**GAO DRAFT REPORT DATED MAY 22, 2012  
GAO-12-629 (GAO CODE 311245)**

**“INFORMATION TECHNOLOGY COST ESTIMATION: AGENCIES  
NEED TO ADDRESS SIGNIFICANT WEAKNESSES IN POLICIES AND  
PRACTICES”**

**DEPARTMENT OF DEFENSE COMMENTS  
TO THE GAO RECOMMENDATIONS**

**RECOMMENDATION 1:** The GAO recommends that the Secretary of Defense direct responsible officials to update future life-cycle cost estimates of the Tactical Mission Command program using cost-estimating practices that address the weaknesses that we identified.

**DoD RESPONSE:** DoD partially concurs with GAO's recommendation. DoD agrees with the criteria, methodology, and assessment of the DoD programs. However, the Tactical Mission Command program made a fielding decision in January 2009 and is currently performing system deployment, and there is currently no plan to formally update the life-cycle cost estimate for this program based on where the Tactical Mission Command program is in the acquisition lifecycle. DoD does, however, recognize the need to use the cost-estimating policies and practices identified in this report across all of our Major Automated Information Systems. Through the Weapons Systems Acquisition Reform Act of 2009, the Director of Cost Assessment and Program Evaluation has a responsibility to review the cost estimated for all Major Automated Information Systems. As a part of that estimate review process the Director of Cost Assessment and Program Evaluation assesses the use of standard cost-estimating practices and adherence to cost-estimating policies in the preparation of these cost-estimates.

# Appendix VII: Comments from the Environmental Protection Agency



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

JUN 29 2012

Valerie C. Melvin, Director  
Information Technology, Human Capital and Management Issues  
U.S. Government Accountability Office  
441 G Street, N.W.  
Washington, D.C. 20548

Dear Ms. Melvin:

Thank you for the opportunity to comment on the draft report entitled "Information Technology Cost Estimation: Agencies Need to Address Significant Weaknesses in Policies and Practices (GAO-12-629)." Sound fiscal management practices should be followed in all aspects of the Agency's information technology operations, including cost estimating for the development of new systems.

EPA recognizes GAO's comment that "agency policies did not require cost-estimating best practices." We believe that the *GAO Cost Estimating Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, DC: March 2009) is a valuable resource. In recognition of GAO's comment, EPA will update our Systems Life Cycle Management (SLCM) procedures, as suggested.

With regard to GAO's assessment of the Financial System Modernization Project (FSMP), EPA does not have specific comments.

The remainder of this letter includes our general comments on the approach and findings of this assessment as it relates to the Superfund Enterprise Management System (SEMS). Detailed responses to the findings are included in the enclosure.

#### **General Comments regarding SEMS**

We do not believe that the GAO assessment accurately reflects the cost estimating practices employed for the development of SEMS. The Office of Solid Waste and Emergency Response (OSWER) believes that the SEMS project has met the spirit and intent of the cost estimating guidelines outlined in *GAO Cost Estimating Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, DC: March 2009). However, EPA may have used different processes or documentation in order to do so.

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Although we believe that the 2009 GAO cost estimation guide is a valuable resource, given the variation, uncertainty, and widely different contexts that cost estimation occurs, we feel it can only serve as a guide. First, the GAO guide was not published until three years after the SEMS development commenced. The Agency maintains a rigorous approach to system development and system operations. SEMS is rich in documentation, as demonstrated by more than 200 documents that were shared with the GAO review team. The production has followed EPA system life cycle management policy, and has withstood intense internal and external review.

The draft GAO report erroneously concludes that the SEMS cost estimate increased from \$39.3 million to \$62.0 million in just two years. As has been previously explained to GAO, this revised cost estimate was a direct result of a change in the duration of O&M included in each calculation. The \$39.3 million figure represented an estimate until the end of FY 2013, while the \$62.0 million figure represents an estimate through FY 2017 and was accepted as part of formal rebaselining under the Capital Planning and Investment Control (CPIC) process governed by the Office of Management and Budget (OMB).

**Conclusion**

As the enclosed detailed response demonstrates, the SEMS project has been subject to a multitude of independent reviews, internal senior management reviews, cost benefit analyses, sensitivity and risk analyses, and CPIC approvals by OMB. These processes and documents demonstrate a clear commitment to effective planning and management of SEMS cost estimation that is not recognized by the GAO assessment. We suggest that the assessment team evaluate these actions against the spirit and intent of the cost estimating guidelines.

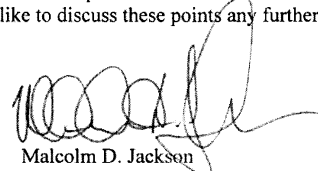
While we do not agree with the findings of this assessment relative to SEMS, we do feel that the GAO cost estimation guide is a valuable tool for future IT cost estimation efforts. We will also continue to comply with applicable Agency policy and procedures when developing cost estimates for other systems, and when updating estimates with respect to SEMS.

Please feel free to contact Vaughn Noga, Director of the Office of Technology Operations and Planning in the Office of Environmental Information on (202) 566-0300 or Robin Richardson, Director of the Resources Management Division in the Office of Superfund Remediation and Technology Innovation, at (703) 603-9048, if you would like to discuss these points any further.

Sincerely,



Mathy Stanislaus  
Assistant Administrator  
Office of Solid Waste and Emergency Response



Malcolm D. Jackson  
Assistant Administrator and  
Chief Information Officer  
Office of Environmental Information

Enclosure



# Appendix VIII: Comments from the Department of Homeland Security

U.S. Department of Homeland Security  
Washington, DC 20528



**Homeland  
Security**

June 22, 2012

Valerie C. Melvin  
Director, Information Management and Technology Resources Issues  
U.S. Government Accountability Office  
441 G Street, NW  
Washington, DC 20548

Re: Draft Report GAO-12-629, "INFORMATION TECHNOLOGY COST ESTIMATION:  
Agencies Need To Address Significant Weaknesses in Policies and Practices"

Dear Ms. Melvin:

Thank you for the opportunity to review and comment on this draft report. The U.S. Department of Homeland Security (DHS) appreciates the U.S. Government Accountability Office's (GAO) work in conducting its review and issuing this report.

The Department is pleased to note GAO's positive acknowledgement of DHS' continued progress in establishing and implementing effective cost estimating processes. In particular, we appreciate GAO's recognition that DHS has "fully addressed" several of the key components of effective cost-estimating policy, such as adherence to the use of best practices. This includes relying extensively on the GAO Cost Estimating and Assessment Guide, and working through Acquisition and Program Management Centers of Excellence to provide tailored training workshops for Component personnel.

The draft report contained two recommendations directed at DHS, with which the Department concurs. Specifically, GAO recommended that the Secretary of Homeland Security direct responsible officials to:

**Recommendation 1:** Modify policies governing cost estimating to ensure that they address the weaknesses that we identified.

**Response:** Concur. The Office of Program Accountability and Risk Management (PARM) is currently developing a process to transform the Department's Acquisition Management Directive (D) 102-01 and accompanying instructions into a more usable and flexible structure. The transformation will include development of a revised cost estimating policy that will further incorporate GAO best practices, as appropriate.

**Recommendation 2:** Update future life-cycle cost estimates of the system acquisition programs discussed in this report using cost-estimating practices that address the detailed weaknesses that we identified.

**Response:** Concur. PARM is developing a scorecard for assessing programs' Life Cycle Cost Estimates based on GAO best practices. PARM is also working through the Acquisition and Program Management Centers of Excellence to provide training workshops on cost estimating to address the weaknesses identified by GAO and any gaps identified by the scorecard process. The workshops are available to personnel in all major programs throughout the Department.

Again, thank you for the opportunity to review and comment on this draft report. Please feel free to contact me if you have any questions. We look forward to working with you in the future.

Sincerely,



Jim H. Crumpacker  
Director  
Departmental GAO-OIG Liaison Office

# Appendix IX: Comments from the Department of Labor

U.S. Department of Labor

Office of the Assistant Secretary  
for Administration and Management  
Washington, D.C. 20210



JUN 22 2012

Ms. Valerie C. Melvin  
Director  
Information Management and  
Technology Resources Issues  
Government Accountability Office  
441 G Street, NW  
Washington, D.C. 20548

Dear Ms. Melvin:

Thank you for the opportunity to review and comment on the Draft Government Accountability Office (GAO) Report #GAO-12-629, *Information Technology Cost Estimation: Agencies Need to Address Significant Weaknesses in Policies and Practices*.

The Department of Labor (DOL) appreciates the recommendations provided by GAO regarding cost estimating within the Department. As DOL has previously stated, we have a relatively small IT portfolio which does not justify the cost of establishing a central, independent office dedicated to cost estimating. Through our existing policy, as reflected in our Baseline Management Guide (BMG), the IT Cost Estimation Guide (an Appendix within the BMG), and our Post Implementation Review (PIR) process – and reinforced through training to agency IT managers – we continue to document and improve our IT cost estimation.

The DOL BMG further describes standard, detailed requirements for creating and modifying a Project Plan with the appropriate level and type of work products, and directs the collection of lessons learned related to cost estimates in the Integrated Baseline Review and then again in the PIR stages of an IT investment's lifecycle.

To ensure agency IT acquisitions are managed as strategic business resources, the Department has created an IT Acquisition Review Board (ITARB). The ITARB is accountable for the approval of funds for all IT acquisitions, including infrastructure, products, commodities, and services to ensure alignment with the Department's IT Modernization and strategic sourcing initiatives. This effort will assist the agencies in the long term by working towards a more streamlined and consolidated approach to IT goods and services acquisitions, thus saving time and money agencies could use to meet their program goals.

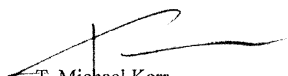
It is also important to note that the Office of the Chief Information Officer (OCIO) participates in the budget formulation process at the Departmental level for the annual budget submission to the Office of Management and Budget.

Additionally, the Occupational Safety and Health Administration (OSHA) offers the following comments:

OSHA believes that GAO's "Not Met" Assessment of the "Credible" characteristic for the OIS program is too low and should be assessed as at least "Partially Met." The focus of GAO's assessment is on the 2010 cost estimate to the exclusion of all other evidence provided for the program. The complete set of estimating tools for the 2010 estimate was not available so, at GAO's request, OSHA provided additional supporting evidence for OSHA cost estimating practices, particularly the 2008 documentation. However, the assessment does not give consideration to this additional documentation in this assessment.

OSHA follows DOL's standard cost estimating policies and practices using standardized cost estimating tools with sensitivity analysis, risk adjustments, alternatives analysis, and financial analysis built into the templates as demonstrated in the 2008 documentation. Furthermore, an independent cost estimate was conducted at the outset of the program by an industry-leading IT consulting firm as recommended by the DOL OIG using the most widely respected and time-tested software development estimating methodology.

Sincerely,



T. Michael Kerr  
Assistant Secretary for  
Administration and Management

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# Appendix X: Comments from the Pension Benefit Guaranty Corporation

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Pension Benefit Guaranty Corporation  
1200 K Street, N.W., Washington, D.C. 20005-4026

Office of the Director

June 18, 2012

Valerie C. Melvin, Director  
Information Management and Technology Resource Issues  
U.S. Government Accountability Office  
Washington, D.C. 20548

Re: GAO Study of Cost Estimating Practices for Selected Information  
Technology Investments (Job Code: 311245)

Dear Ms. Melvin:

Thank you for the opportunity to comment on your draft report.

We are pleased that GAO concluded that PBGC met a large portion, or at least half, of GAO's quality indicators in each of its four categories of cost estimating: Comprehensive, Well-documented, Accurate, and Credible.

This is even more significant considering that PBGC is much smaller than the other agencies referenced in the report, and does not have the same level of resources to dedicate to cost estimating infrastructure. PBGC takes estimating system costs seriously, and places a great deal of emphasis on system planning, implementation, and oversight to help ensure that we receive an appropriate return on our system investments.

As well as PBGC performs, we understand that there is always room for improvement. Consistent with your recommendation, PBGC will evaluate and improve future life-cycle cost estimates for the Benefit Administration (BA) investment in ways that appropriately consider GAO's framework, while balancing the resources available in a small agency.

The extent of the improvements will also reflect the context of the BA investment moving to a predominately Operations & Maintenance (O&M) stage. Along the way, Development, Modernization & Enhancements (DM&E) releases will address critical audit findings, prudently keep pace with technology, support legislative changes relating to the Pension Protection Act of 2006, and accommodate unforeseen complexities in pension plans that will

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**Appendix X: Comments from the Pension  
Benefit Guaranty Corporation**

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be trusted in the future. Additionally, the findings outlined in this report will be considered as we continue to refine our existing Total Cost of Ownership (TCO) Guidance document and we apply the TCO concept to other IT Projects, in addition to the BA investment. Our updated TCO guidance document and related TCO training will be available in September 2013, and an updated plan on "Improving BA Investments" is slated for completion in September 2014. As Table 22 of the draft report indicates, we plan on reducing total life-cycle costs of the BA program over the next few years.

Please contact Martin O. Boehm at 202-326-4161, ext. 3901, should you have any questions.

Sincerely,



Josh Gotbaum

cc: Barbara Boybjerg, GAO, Director- EWIS  
Patricia Kelly, CFO  
Richard Macy, CIO  
Vince Snowbarger, DDO  
Judith Starr, General Counsel  
Martin O. Boehm, CCRD

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# Appendix XI: Comments from the Department of Veterans Affairs

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DEPARTMENT OF VETERANS AFFAIRS  
WASHINGTON DC 20420  
June 26, 2012

Ms. Valerie C. Melvin  
Director, Information Management  
and Technology Resource Issues  
U.S. Government Accountability Office  
441 G Street, NW  
Washington, DC 20548

Dear Ms. Melvin:

The Department of Veterans Affairs (VA) has reviewed the Government Accountability Office's (GAO) draft report, "**INFORMATION TECHNOLOGY COST ESTIMATION: Agencies Need To Address Significant Weaknesses in Policies and Practices**" (GAO-12-629) and generally agrees with GAO's conclusions.

The enclosure specifically addresses GAO's two recommendations, provides an action plan, and includes a technical comment. VA appreciates the opportunity to comment on your draft report.

Sincerely,

A handwritten signature in cursive script that reads "John R. Gingrich".

John R. Gingrich  
Chief of Staff

Enclosure

Enclosure

Department of Veterans Affairs (VA) Comments to  
Government Accountability Office (GAO) Draft Report,  
***“INFORMATION TECHNOLOGY COST ESTIMATION: Agencies Need  
To Address Significant Weaknesses in Policies and Practices”***  
(GAO-12-629)

**GAO Recommendation 1:** We recommend that the Secretary of Veterans Affairs direct responsible officials to modify policies governing cost estimating to ensure that they address the weaknesses that we identified.

**VA Comment:** VA concurs with the recommendation for clarifying VA policy for cost estimating at an appropriate level. As a long term solution to support strategic cost estimation, the Office of Information and Technology (OI&T) is evaluating the utility of establishing an organizational function focused solely on multiyear estimation. This function is presently distributed to multiple sub-units within OI&T based on responsibility for different parts of the Software Development Lifecycle. The organization element would be charged with supporting the articulation of multiyear programs via the delivery of cost and performance metrics gathered during increment and project delivery. This decentralization took place because VA, as part of our transformational efforts in IT, focused intensely on incremental delivery to force an adoption of an agile methodology for project success across the enterprise. The current environment focuses on incremental delivery of business requirements first and then management of programs (page 15 of this GAO report), consolidating this function could be a step toward maturing a capability to estimate both increment-based and lifecycle costs. VA seeks to complete this evaluation by the end of the first quarter, fiscal year 2013.

While this evaluation is underway, VA is improving cost-estimating practices for IT efforts at the increment level in support of program management. Efforts presently underway include implementing obligation, cost, and staff time capture at the increment level as well as developing an increment-type taxonomy. With availability and utilization of this increment-level information, Program Managers and Platform/Product Managers will be better equipped to assist in forward projection of costs.

VA is completing our transition from a Waterfall only approach to project delivery to an approach based on an incremental delivery of customer facing functionality utilizing Agile principles. In a Waterfall approach, the development of component pieces of a larger software package is carried out in sequential phases with no consistent, fixed duration to complete full development. With an incremental approach, initial planning regarding cost, scope, and timing is conducted at a high level. Following initial high-level planning, specific plans are developed for each iteration of the project. High-level plans are then modified as necessary. This process results in better estimates of both increment-based and lifecycle cost estimation than is typically the case with a Waterfall approach. But more importantly, an incremental approach has a significantly higher success rate in the delivery of customer facing functionality to enable mission accomplishment.



Enclosure

Department of Veterans Affairs (VA) Comments to  
Government Accountability Office (GAO) Draft Report,  
***"INFORMATION TECHNOLOGY COST ESTIMATION: Agencies Need  
To Address Significant Weaknesses in Policies and Practices"***  
(GAO-12-629)

**GAO Recommendation 2:** We recommend that the Secretary of Veterans Affairs direct responsible officials to update future life-cycle cost estimates of the system acquisition programs discussed in this report using cost-estimating practices that address the detailed weaknesses that we identified.

**VA Comment:** VA concurs with the recommendation. VA is improving cost-estimating practices for IT efforts at the increment level in support of program management. Initial project manager training was conducted within the last ninety days, and additional training is scheduled early in fiscal year 2013. Other efforts presently underway include implementing obligation, cost, and staff time capture at the increment and project levels. The results will be utilized to improve future life-cycle estimates.

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# Appendix XII: GAO Contact and Staff Acknowledgments

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## GAO Contact

Valerie C. Melvin, (202) 512-6304 or [melvinv@gao.gov](mailto:melvinv@gao.gov)

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## Staff Acknowledgments

In addition to the contact name above, individuals making contributions to this report included Eric Winter (Assistant Director), Mathew Bader, Carol Cha, Jennifer Echard, J. Christopher Martin, Lee McCracken, Constantine Papanastasiou, Karen Richey, Matthew Snyder, and Jonathan Ticehurst.

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Katherine Siggerud, Managing Director, [siggerudk@gao.gov](mailto:siggerudk@gao.gov), (202) 512-4400, U.S. Government Accountability Office, 441 G Street NW, Room 7125, Washington, DC 20548

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## Public Affairs

Chuck Young, Managing Director, [youngc1@gao.gov](mailto:youngc1@gao.gov), (202) 512-4800 U.S. Government Accountability Office, 441 G Street NW, Room 7149 Washington, DC 20548

