

September 2008

NEXT GENERATION
AIR
TRANSPORTATION
SYSTEM

Status of Systems
Acquisition and the
Transition to the Next
Generation Air
Transportation System



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Highlights of GAO-08-1078, a report to congressional requesters

Why GAO Did This Study

The Joint Planning and Development Office (JPDO), an interagency organization within the Federal Aviation Administration (FAA), was created to plan and coordinate research and development for the next generation air transportation system (NextGen). Transitioning to NextGen will require FAA to continue to acquire new air traffic control (ATC) systems on schedule and on budget. GAO's concerns about the size, complexity, and cost of FAA's acquisition of ATC systems led GAO to designate this issue as high-risk in 1995. NextGen includes system acquisitions but is a significantly larger initiative involving multiple federal agencies, such as the National Aeronautics and Space Administration (NASA), which conducts aeronautics research and development for NextGen, and nonfederal aviation stakeholders, such as aviation equipment manufacturers, airports, and aircraft operators.

GAO addressed (1) FAA's ATC systems acquisition activities, (2) key NextGen planning and transition issues, and (3) key challenges that FAA faces in implementing NextGen. GAO reviewed FAA's management processes and cost and schedule data for acquiring ATC systems, interviewed senior FAA, JPDO, and NASA officials, and 24 aviation stakeholders involved in NextGen. This report is also based on recent GAO products. The Department of Transportation (DOT) and NASA provided technical corrections, which GAO included.

To view the full product, including the scope and methodology, click on GAO-08-1078. For more information, contact Gerald Dillingham at (202) 512-2834 or dillingham@gao.gov.

NEXT GENERATION AIR TRANSPORTATION SYSTEM

Status of Systems Acquisition and the Transition to the Next Generation Air Transportation System

What GAO Found

The majority of FAA's key ATC acquisition programs are currently being managed within the established cost and time estimates since FAA created the performance-based Air Traffic Organization (ATO) in 2004 and improved its management of acquisitions. The agency has demonstrated executive-level commitment to addressing systemic factors that have contributed to historic cost overruns and schedule delays. FAA's response to over 45 recommendations by GAO contributed to significantly improved acquisition management. While FAA has implemented numerous acquisition management practices, areas remain that need further improvement, such as ensuring transparency on rebaselined programs. FAA plans to address this issue by reporting annually to Congress the original budget and schedule baselines and the reasons for the rebaselining. FAA needs to continue its progress in managing acquisitions, since it will be acquiring billions of dollars of new systems as part of the NextGen transformation.

JPDO has completed the initial versions of three basic planning documents for NextGen, but many aviation stakeholders felt the documents, which focus on a 2025 time frame, lack the information that industry needs to make near-term business decisions to support NextGen. The next version of the NextGen work plan, scheduled to be issued in September 2008, will address some of these concerns. ATO recently reorganized to facilitate the transition to NextGen, but it is too early to tell if the reorganization addresses concerns about the fragmented management structure for NextGen, since multiple offices in ATO and FAA continue to have responsibility for NextGen.

FAA's ability to implement NextGen will be affected by how it addresses research and development, human capital, and infrastructure challenges. Although research and development are critical for NextGen, research gaps exist because of a recent decline in NASA's aeronautical research funding and the expanded requirements of NextGen. FAA faces a human capital challenge of having the necessary knowledge and skills, such as contract management and system engineering expertise, to implement NextGen. In response to GAO's prior recommendation, in September 2008, FAA expects to complete an analysis comparing the skills needed for NextGen with its current staff resources. However, it may take considerable time to hire what FAA estimates could be up to 200 more staff with the needed skills. FAA also faces the challenge of maintaining and repairing existing ATC infrastructure, such as radar stations, while consolidating or realigning its facilities to accommodate NextGen technologies and operations. An additional infrastructure challenge is increasing airport runway capacity to handle the expected increases in traffic. While FAA's plans call for building or expanding runways at the nation's 35 busiest airports, its analyses indicate that 14 more airports will still need additional runway capacity. These efforts to expand capacity by means of runway development could be delayed without significant reductions in emissions and noise around some airports.

Contents

Letter		1
	Results in Brief	2
	Background	4
	Most Acquisition Programs Are Meeting Cost and Schedule Estimates since the Creation of ATO	7
	Basic Planning for NextGen Is Completed and ATO Has Reorganized as It Transitions to NextGen, but Stakeholders Have Concerns	12
	FAA's Ability to Implement and Obtain Expected Benefits from NextGen Will Be Affected by Research and Development, Human Capital, and Infrastructure Challenges	21
Appendix I	Scope and Methodology	35
Appendix II	Stakeholder Responses to Semistructured GAO Interview Questions	38
Appendix III	ATC Acquisition Performance	40
Appendix IV	Baseline History for Programs Selected for Acquisition Performance Measurement	42
Appendix V	GAO Contact and Staff Acknowledgments	44
Figures		
	Figure 1: Standard Terminal Automation Replacement System Controller Workstation	11
	Figure 2: FAA Organization, November 2007	17
	Figure 3: ATO Organization, July 2008	20
	Figure 4: NASA's Aeronautics Research Budget for Fiscal Years 2003 through 2008 and Proposed Budget through Fiscal Year 2013, in Constant 2008 Dollars	22

Figure 5: FAA's Overall Research and Development Funding for
Fiscal Years 2006 through 2008 and Proposed Funding
through Fiscal Year 2013, in Constant 2008 Dollars

23

Figure 6: Example of Use of ADS-B

27

Abbreviations

ADS-B	Automatic Dependent Surveillance-Broadcast
ATC	air traffic control
ATO	Air Traffic Organization
CDA	Continuous Descent Arrival
CLEEN	Continuous Lower Energy, Emissions, and Noise
COO	Chief Operating Officer
DOT	Department of Transportation
ERAM	En Route Automation Modernization
FAA	Federal Aviation Administration
JPDO	Joint Planning and Development Office
MOU	memorandum of understanding
NAPA	National Academy of Public Administration
NASA	National Aeronautics and Space Administration
NATCA	National Air Traffic Controllers Association
NextGen	next generation air transportation system
OEP	Operational Evolution Partnership
OMB	Office of Management and Budget
PASS	Professional Aviation Safety Specialists
RNAV	Area Navigation
RNP	Required Navigation Performance
SWIM	System-Wide Information Management
UPS	United Parcel Service

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United States Government Accountability Office
Washington, DC 20548

September 11, 2008

Congressional Requesters

The nation's air transportation system is experiencing some of the worst delays in recent times with one in four flights facing delays. Currently, the U.S. air transportation system handles about 50,000 flights over a 24-hour period. By 2025, air traffic is projected to increase two- to three-fold, equating to about 100,000 to 150,000 flights every 24 hours. It is acknowledged that the current U.S. air transportation system will not be able to meet these air traffic demands. In 2007, the aviation industry recorded the second worst year for delays since 1995; 27 percent of flights were delayed or canceled in 2007. According to the Senate Joint Economic Committee these delays cost passengers, airlines, and the U.S. economy over \$40 billion. Although air traffic overall was down in the first half of 2008, in part because of economic factors that have led airlines to reduce service, there has been no significant reduction in traffic at the most congested airports, such as those in the New York and New Jersey area. Congestion and delays at key airports cascade across the entire system. Moreover, according to FAA, even if traffic is reduced, congestion at these key airports will not be significantly reduced.

To try to reduce system congestion, FAA is in the process of implementing a number of initiatives, such as redesigning airspace in certain locations to improve efficiency, to try to alleviate choke points in the system. However, the existing air traffic control (ATC) system is not scalable to meet the forecasted traffic increases. To meet this expected increase in traffic, the Joint Planning and Development Office (JPDO) was established by Congress in 2003 to plan and coordinate an interagency effort to create a new air traffic management system that will transform the current radar-based ATC system into a more automated aircraft-centered, satellite-based system. This transformation to the next generation air transportation system (NextGen) will require the acquisition and integration of billions of dollars of sophisticated new ATC technologies with existing or legacy ATC technologies as well as a major shift in the operating paradigm from air traffic control to air traffic management by 2025.

You asked us to assess FAA's ability to acquire and integrate new ATC systems and transition to NextGen. Accordingly, we established the following research questions: (1) What are the status and outcome of FAA's ATC systems acquisition activities? (2) What is the status of the key NextGen planning and transition issues? (3) What key challenges does FAA face in implementing NextGen?

To address these questions, we reviewed documents from FAA, JPDO, and the National Aeronautics and Space Administration (NASA). In addition, we held discussions with senior FAA, JPDO, and NASA officials; interviewed 24 private sector stakeholders involved in the NextGen effort, including representatives of aviation associations, manufacturers, and academics; and updated prior GAO studies. To address key NextGen planning and transition issues and challenges to implementation, we interviewed the 24 NextGen stakeholders and conducted a content analysis of their responses. We then obtained further information related to those responses from relevant NextGen federal partners—FAA, JPDO, and NASA. We did not obtain further information from the other federal partners—the Departments of Commerce, Defense, and Homeland Security and the White House Office of Science and Technology Policy because the stakeholders did not articulate issues related to those agencies. We conducted our performance audit from July 2007 to September 2008 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. Additional information on our methodology is found in appendix I. See appendix II for our content analysis of the stakeholder interviews.

Results in Brief

Most of FAA's major ATC acquisition programs are being managed within the established cost and time estimates since the creation of its performance-based Air Traffic Organization (ATO) in 2004. For example, 24 major acquisition programs experienced a cumulative 2.5 percent cost underage and only a 2.7 percent schedule overage when the baseline status as of February 2004 was compared to the estimated total cost and schedule as of June 2008. These positive cost and schedule outcomes have occurred, in part, as a result of FAA's sustained executive-level commitment and improved acquisition management practices that include establishing a capital investment team to review financial performance data and provide early warnings of potential problems as well as corrective actions. However, since FAA measures progress related to current program baselines, the agency will need to ensure transparency so that rebaselined programs and performance reporting do not mask budget increases and schedule delays, which could have a cascading impact on the cost and schedule of NextGen. FAA plans to report annually to Congress on the original budget and schedule baselines for each rebaselined program and the reasons for the rebaselining.

JPDO has completed the initial versions of three basic planning documents for NextGen—a Concept of Operations, an Enterprise Architecture, and an Integrated Work Plan—and ATO recently reorganized to facilitate the transition to NextGen, but industry stakeholders have concerns about both efforts. Many aviation industry stakeholders we spoke with indicated that they were not satisfied with the impact of their participation in NextGen planning and felt that the planning documents lacked the information the industry needed for NextGen to be implemented by 2025. For example, 19 of 21 industry stakeholders who discussed the issue noted that the planning documents lacked the information that industry participants need for planning, such as information on the requirements or specifications needed to develop and manufacture NextGen equipment or make other business decisions needed to implement NextGen. However, a senior JPDO official noted that the JPDO planning documents were not intended to provide that level of detail. Stakeholders further believe FAA should develop, for the 2015 time frame, an interim planning document that can provide sufficient details about NextGen to help industry plan for the investments they need to make in NextGen systems. According to FAA, it will annually update an interim NextGen planning document to reflect its annual budget submission and that document is currently being revised to reflect the fiscal year 2009 budget submission. Furthermore, the next version of the work plan, scheduled to be issued in September 2008, should address some of the stakeholders concerns. In addition, an effective management structure is a key issue for the transition to NextGen. However, all 10 stakeholders who discussed FAA’s management structure believed that it was not adequate for the transition to NextGen, with multiple executives responsible for NextGen-related activities and the lack of a single manager with authority to make key decisions. In part, to address such comments and facilitate its role in implementing NextGen, ATO recently reorganized, designating a Senior Vice President for NextGen and Operations Planning who reports to ATO’s Chief Operating Officer (COO). However, it is too early to tell if this reorganization addresses concerns about the fragmented management structure for NextGen, since other offices in ATO and FAA continue to have responsibility for parts of NextGen and the division of responsibility for NextGen efforts among the offices is not clear.

FAA’s ability to implement NextGen will be affected by how well it addresses some key challenges, including research and development, human capital, and infrastructure. **Research and development** is still needed to define and demonstrate the new NextGen technology; however, it is uncertain which entities will fund and conduct that research. Budget requests for FAA have increased to help provide the needed research and development funding for NextGen, and NASA and FAA have developed a

strategy to identify, conduct, and transfer research from NASA to FAA to help bridge the gap between NASA's research and FAA's need to implement new technology. Unless NextGen's developmental research needs are met in a timely manner, the implementation of NextGen is also likely to be delayed, jeopardizing NextGen's goals of increased safety, efficiency, and capacity of the system. In addition, FAA faces a **human capital challenge** of having the necessary knowledge and skills, such as systems engineers and contract management expertise, to implement NextGen. In response to our prior recommendation, FAA contracted with the National Academy of Public Administration (NAPA) to determine the mix of skills and number of skilled persons needed to implement NextGen and compare those requirements with FAA's current staff resources. NAPA expects to complete this assessment in September 2008. Once the right skill set is identified, however, it may take considerable time to select, hire, and integrate what FAA estimates could be 150 to 200 more staff. This situation has the potential to contribute to delaying the integration of new technologies and transformation of the national airspace system. Further, FAA faces an immediate challenge to maintain and repair existing **infrastructure** to keep the current ATC system operating safely, while managing its resources to develop facilities that can accommodate NextGen technology and operations. According to FAA, it will require a new configuration of radar facilities to be consistent with NextGen. However, the agency has not developed a cost analysis or implementation plan for reconfiguring its facilities. Until that analysis and plan have been developed, the configurations needed for NextGen cannot be implemented and potential savings realized. In addition, NextGen will depend on the ability of airports to handle greater capacity. FAA's plans call for building or expanding runways at the nation's 35 busiest airports to help meet the expected increases. However, even with these planned runway improvements and the additional capacity gained through NextGen technologies and procedures, FAA analyses indicate that 14 more airports will still need additional capacity. Moreover, without significant reductions in emissions and noise around some of the nation's airports, efforts to expand their capacity could be stalled and the implementation of NextGen delayed. We provided a draft of this report to the Department of Transportation (DOT) and NASA for their review and comments. Both agencies provided technical clarifications, which we incorporated into this report as appropriate.

Background

For over two decades FAA has been conducting a major modernization of its ATC systems but, until the last several years, has had difficulties in meeting cost, schedule, and performance targets in acquiring major systems. In 1995, GAO designated the ATC modernization program as a

high-risk information technology initiative because of its size, complexity, cost, and problem-plagued past. We have issued numerous reports on FAA's inability to meet its acquisition performance goals.¹ In addition, we have reported that four key factors have historically contributed to acquisitions missing their original cost, schedule, and performance targets: (1) acquisitions receiving less funding than called for in agency planning documents, (2) adding requirements or unplanned work, (3) underestimating the complexity of software development, and (4) not sufficiently involving stakeholders throughout system development.²

FAA, in response to over 45 recommendations we have made, has taken steps to improve its acquisition management. For example, when reviewing acquisitions, FAA now focuses on the acquisition's impact on customer service and contribution to achieving the agency's strategic and performance goals, including expanding the overall capacity of the national airspace system, rather than on securing the approval of and managing individual acquisition programs. FAA has also established basic investment management capabilities, including many practices for selecting and controlling its mission-critical information technology investments. Our previous work showed that FAA was not regularly reviewing investments that are more than 2 years into their operations. As a result, FAA was limited in its ability to oversee, as a total package of competing investment options, more than \$1 billion of its information technology investments, and to pursue only those that best meet its goals. As a response to our recommendation, FAA stated that it had changed its acquisition review process to a semiannual "service-level review" process that encompasses systems that are in service. Additionally, FAA has changed its format for justifying major technology investments to that prescribed by the Office of Management and Budget (OMB). According to FAA, this change provides more comprehensive information than the previous format and provides efficiencies by avoiding the need to later translate the information into OMB's prescribed format.

¹GAO, *Air Traffic Control: FAA's Acquisition Management Has Improved, but Policies and Oversight Need Strengthening to Help Ensure Results*, GAO-05-23 (Washington, D.C.: Nov. 12, 2004); *National Airspace System: FAA Has Made Progress but Continues to Face Challenges in Acquiring Major Air Traffic Control Systems*, GAO-05-331 (Washington, D.C.: June 10, 2005); *National Airspace System: Transformation Will Require Cultural Change, Balanced Funding Priorities, and Use of All Available Management Tools*, GAO-06-154 (Washington, D.C.: Oct. 14, 2005); and *Air Traffic Control: FAA Reports Progress in System Acquisitions, but Changes in Performance Measurement Could Improve Usefulness of Information*, GAO-08-42 (Washington, D.C.: Dec. 18, 2007).

²GAO-05-331.

In August 2005, FAA submitted a plan to OMB of steps it intended to take to remove ATC modernization from GAO's high-risk list. FAA submitted this plan in response to a request from OMB, which had asked agencies with programs on GAO's high-risk list to identify their goals for reducing fraud, waste, or mismanagement.

In addition to our recommendations and those of the Department of Transportation Inspector General³ for improving FAA's acquisition management, Congress and others have taken steps to address these issues. For example, in 1997, the congressionally appointed National Civil Aviation Review Commission recommended, among other things, that FAA's management become more performance-based. In December 2000, President Clinton signed an executive order, and Congress passed supporting legislation that, together, provided FAA with the authority to create the performance-based ATO to control and improve FAA's management of the modernization effort. FAA reorganized, transferring 36,000 employees, most of whom worked in air traffic services and research and acquisitions, to ATO in February 2004. By creating ATO, headed by a chief operating officer, FAA established a new, flatter organizational structure and adopted more leading practices of private sector businesses to address the cost, schedule, and performance shortfalls that have plagued ATC acquisitions.

In 2003, Congress mandated the creation of JPDO,⁴ housed within FAA but involving several federal partner agencies, for the agencies to conceptualize and plan for NextGen. The previous ATC modernization program largely consisted of FAA's efforts to acquire more sophisticated ATC equipment with a 10-year planning horizon. NextGen also includes the acquisition of ATC systems. Moreover, NextGen is a multidecade, multiagency effort to transform the current air traffic system to the next generation air transportation system by moving from largely ground-based radars to precision satellite-based navigation and includes digital, networked communications and an integrated weather system. NextGen involves the coordinated research activities of multiple federal agencies, including NASA, FAA, and the Departments of Commerce, Defense, and

³Department of Transportation, Office of Inspector General, *Air Traffic Control Modernization: FAA Faces Challenges in Managing Ongoing Projects, Sustaining Existing Facilities, and Introducing New Capabilities* (Washington, D.C.: Apr. 14, 2008), and *Status of FAA's Major Acquisitions: Cost Growth and Schedule Delays Continue To Stall Air Traffic Modernization* (Washington, D.C.: May 26, 2005).

⁴Vision 100—Century of Aviation Reauthorization Act, Pub. L. No. 108-176, § 709. The office began operating in early 2004.

Homeland Security. To achieve the NextGen vision, JPDO was charged with coordinating research activities of the federal agencies in developing the 20-year research and development program for NextGen. FAA will play the central role in implementing NextGen, as it will be responsible for acquiring, integrating, and operating the new ATC systems. Industry stakeholders will also play a key role in implementing NextGen because they are expected to develop, finance, and operate many of the new NextGen systems that will need to be installed in aircraft. JPDO reported in 2006 that the total cost for NextGen infrastructure may range from \$15 billion to \$22 billion. The agency also noted that it expects a corresponding cost to system users, who will have to equip themselves with the advanced avionics necessary to realize the full benefits of some NextGen technologies, in the range of \$14 billion to \$20 billion.

Most Acquisition Programs Are Meeting Cost and Schedule Estimates since the Creation of ATO

Since the creation of ATO in 2004, FAA has shown significant improvement in its management of ATC modernization through better acquisitions management and the introduction of more efficient business practices. FAA has demonstrated executive-level commitment to addressing the systemic factors that we have identified as contributing to FAA's historic cost overruns and schedule delays. Since 2004, many more acquisition programs are being completed within the original cost and time estimates than prior to ATO's existence. FAA data show that from February 2004 to June 2008, 24 major acquisition programs experienced a cumulative 2.5 percent cost underage and a cumulative 2.7 percent schedule overage. Of the 24 programs, 19 were at or less than the baseline cost estimate and 15 were at or earlier than the baseline schedule estimate. However, the two programs with the largest reductions in cost—Airport Surveillance Radar Model 11 and FSAS Operations and Supportability System—also had large reductions in the number of systems to be acquired.⁵ Additional information on the 24 programs is shown in appendix III.

A specific example of a successful acquisition management outcome is ATO's success in keeping the En Route Automation Modernization (ERAM)—considered the heart of the new ATC system—acquisition on schedule and close to budget. The ERAM acquisition began in 2003, a few

⁵ Airport Surveillance Radar Model 11 was originally estimated to cost \$916.2 million to acquire 112 systems; the estimated cost at completion was reduced to \$696.5 million to acquire 66 systems. Similarly, FSAS Operations and Supportability System was originally estimated to cost \$249.4 million for installations at 61 sites; the estimated cost at completion was reduced to \$169.0 million for installations at 16 sites.

months before FAA formed ATO. ERAM replaces the software and hardware in the host computers at FAA's 20 en route ATC centers, which provide separation, routing, and advisory information to aircraft. We and the Department of Transportation's Inspector General identified ERAM as a high-risk effort because of its size and complex software requirements. According to FAA, ERAM has met its original schedule and has remained close to its original budget.⁶ Officials in the ERAM program office attribute the program's success to a number of factors, including having a thorough understanding of the project's requirements and costs prior to establishing a baseline, imposing disciplined requirements control, having early stakeholder involvement, and having a stable budget. Our research has shown that the absence of these factors contributed to past problems in acquisitions achieving cost and schedule targets. ERAM officials also noted benefits from ATO's flatter organizational structure and the consolidation of responsibility for acquisitions and operations under a single manager, the COO. They said, for example, that the elimination of organizational stovepipes has allowed important conversations to take place without going through several layers of administration. These officials also noted that working under the former organizational structure was much more difficult.

The positive cost and schedule outcomes have occurred subsequent to ATO's improved acquisition management practices. More specifically, to better manage its acquisitions, ATO has done the following:

- Established a portfolio approach to managing investments. This approach allows ATO to evaluate the relative merits of spending funds to develop new systems, enhance current systems, or continue operating and maintaining existing systems.
- Applied a business case approach to each project, which includes an analysis of assumptions, constraints, and alternatives to the project, and for each alternative, the full life cycle cost, benefit, schedule, risk, and economics.

⁶Our recent work raised questions about the reliability of some ERAM contractor data. We recommended that the ERAM program office determine the root causes of the anomalies we found in the contractor's data and develop a corrective action plan to resolve the problem. GAO, *Air Traffic Control: FAA Uses Earned Value Techniques to Help Manage Information Technology Acquisitions, but Needs to Clarify Policy and Strengthen Oversight*, GAO-08-756 (Washington, D.C.: July 18, 2008).

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- Established a capital investment team to review financial and performance data. These reviews provide early warnings of potential problems as well as help to develop corrective actions.
 - Implemented earned value management on all new major acquisitions as a way to prevent, detect, report, and correct problems in acquiring major systems and to ensure that major programs are within budget and schedule targets.⁷ While ATO has taken important steps to implement earned value management policies, we have found that it needs to strengthen its policies governing earned value management and add rigor to its oversight processes.⁸
 - Developed and applied a process improvement model in a number of software-intensive system acquisitions, resulting in, among other things, enhanced productivity and greater ability to predict schedules and resource needs.
 - Undertaken human capital initiatives to improve its acquisition workforce culture and build toward a results-oriented, high-performing organization.
 - Established annual acquisition performance goals to improve oversight and accountability over acquisition processes.

Additionally, agency executives have met regularly with GAO and OMB over the past 2 years to provide updates on FAA's efforts to improve its handling of ATC modernization and ensure transparency about these efforts both inside and outside the agency. These meetings have included updates on the status of a corrective action plan that FAA is implementing to institutionalize sound acquisition management practices and successful performance and outcomes. FAA is also working to establish an internal oversight capability to validate the information that executives receive on the status of the plan. OMB has seen sufficient progress in FAA's efforts to address the risk associated with ATC modernization that the meetings now occur semiannually, rather than quarterly.

⁷Earned value management compares the actual work performed at certain stages of a job to its actual costs—rather than comparing budgeted and actual costs, the traditional management approach to assessing progress. By measuring the value of the work that has been completed at certain stages in a job, earned value management can alert program managers, contractors, and administrators to potential cost growth and schedule delays and to problems that need correcting before they worsen.

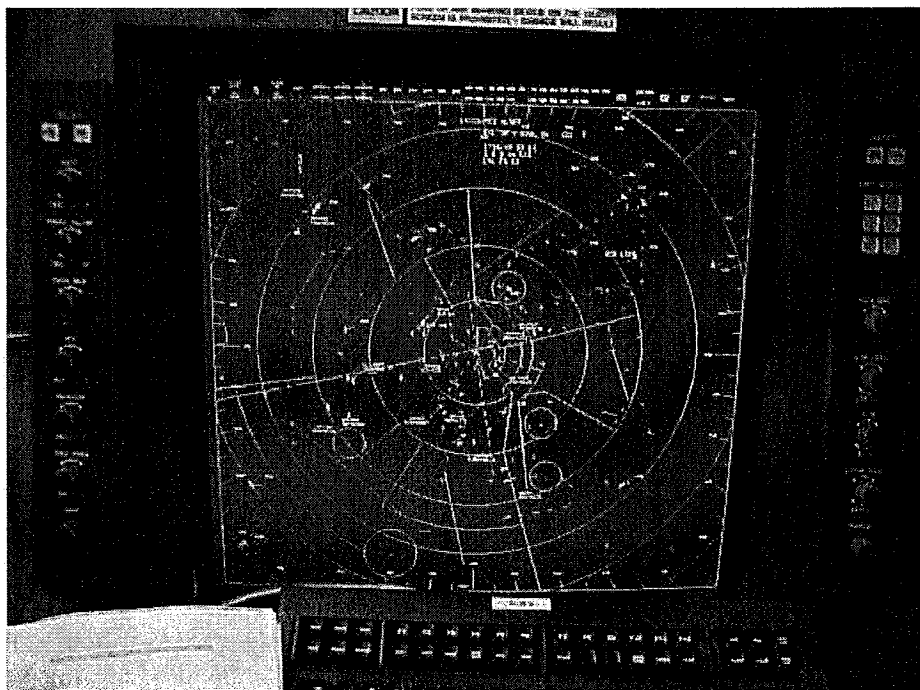
⁸GAO-08-756.

While FAA has made progress in improving acquisition management practices in the 4 years since ATO was created, areas remain that need further improvement. For example, in prior work we found that FAA does not publicly report changes in the cost and schedule baselines for some major ATC acquisitions and thus may not provide Congress and the public with a complete picture of the agency's overall performance in acquiring these systems.⁹ Such unreported rebaselining could make budget increases and schedule delays more difficult to identify. For instance, for fiscal years 2004 through 2006, FAA reported exceeding its annual goals to keep a high percentage of the major acquisition programs within 10 percent of budget and on schedule 80 percent of the time. However, we found that FAA measures progress related only against current program baselines and does not disclose when a system has been rebaselined (when cost and schedule targets have been officially changed). According to ATO's performance reports, the organization showed nearly steady improvement in fiscal years 2003 through 2006 and substantially exceeded its targets for those years, twice reaching 100 percent. However, when performance was measured against original baselines instead of annual budgets or milestones, acquisition performance was lower than reported, but still showed a general trend of improvement for that period. We believe that rebaselining may be appropriate in some cases and that measuring performance against the current baseline has value. However, annual measurements for acquisitions that have been rebaselined and span several years do not provide a complete picture of acquisition performance over time.

In addition, based on original cost and schedule baselines, the acquisitions on which FAA reported performance from 2003 to 2006 collectively exceeded their original budget estimates by approximately \$4.4 billion, or over 66 percent, and experienced schedule slippages of from 1 to 10 years. The Standard Terminal Automation Replacement System (see fig. 1) and the Wide Area Augmentation System—both key NextGen systems—accounted for most of the budget increase. The acquisition of both of these systems began in the mid- to late 1990s, well before the establishment of ATO. (See app. IV for a baseline history of the acquisition programs FAA selected for performance measurement.)

⁹GAO-08-42. For additional reports on rebaselining, see GAO, *Information Technology: Agencies Need to Establish Comprehensive Policies to Address Changes to Projects' Cost, Schedule, and Performance Goals*, GAO-08-925 (Washington, D.C.: July 31, 2008), and GAO-08-756.

Figure 1: Standard Terminal Automation Replacement System Controller Workstation



Source: FAA.

In December 2007, we recommended that FAA identify or establish a vehicle for regularly reporting to Congress and the public on the agency's overall, long-term performance in acquiring ATC systems by providing original budget and schedule baselines for each rebaselined program and the reasons for the rebaselining.¹⁰ We also recommended that FAA report information on the potential effects that any budget increases or schedule slippages could have on the overall transition to NextGen. FAA plans to address our recommendation by reporting such information in its Capital Improvement Plan, which it sends annually to Congress.

FAA will need to continue to manage the acquisition of billions of dollars worth of new ATC systems as NextGen progresses. FAA plans to spend roughly \$5.4 billion from fiscal years 2009 through 2013 on NextGen development and capital costs. The agency estimates that the total federal

¹⁰GAO-08-42.

cost for NextGen infrastructure through 2025 will range from \$15 billion to \$22 billion.¹¹ Therefore, it is now more important than ever for FAA to continue to maintain progress and avoid cost overruns and schedule delays, since they could have a cascading impact on the cost and schedule of NextGen.

Basic Planning for NextGen Is Completed and ATO Has Reorganized as It Transitions to NextGen, but Stakeholders Have Concerns

Congress authorized JPDO to plan and coordinate the development of NextGen and placed JPDO organizationally within FAA. JPDO initially prepared three basic planning documents for NextGen—a Concept of Operations, an Enterprise Architecture, and an Integrated Work Plan.¹² Collectively, the three documents form the basis of the joint planning environment for NextGen. Further iterations of these planning documents will be needed as NextGen technologies are developed and implemented. As NextGen has now progressed from the initial planning to the early implementation phase, JPDO's role has evolved to include coordination and facilitation among the numerous federal and industry stakeholders, JPDO has sought to institutionalize the collaborative process with partner federal agencies by establishing a memorandum of understanding (MOU), signed by the secretary or other high-ranking official from each partner agency that broadly defines the partner agency's roles and responsibilities. As of June 2008, the MOU had been signed by all five partner agencies—the Departments of Commerce, Defense, Homeland Security, and Transportation and NASA. For the transition to NextGen, ATO has undergone a reorganization to facilitate its critical role in implementing NextGen. However, stakeholders have raised concerns about their lack of impact on NextGen planning, the usefulness of key planning documents, and the adequacy of FAA's management structure, including the organizational placement of JPDO, for implementing NextGen.

¹¹This figure includes costs to other federal agencies that will acquire or help develop NextGen systems, such as the Transportation Security Administration within the Department of Homeland Security.

¹²The Concept of Operations describes how the NextGen system is envisioned to operate in 2025 and beyond and identifies key research and policy issues. The Enterprise Architecture is a technical description of the NextGen system, akin to blueprints for a building; it is meant to provide a common tool for planning and understanding the complex, interrelated systems that will make up NextGen. JPDO's Integrated Work Plan is akin to a project plan and is meant to describe the capabilities needed to transition to NextGen from the current system and provide the research, policy, regulation, and acquisition timelines necessary to achieve NextGen by 2025.

Stakeholders Are Not Satisfied with their Participation in NextGen Planning or the Information Provided in NextGen Planning Documents

Thirteen of 15 industry stakeholders¹³ who discussed the issue raised concerns over what they perceive as a lack of impact on NextGen planning from their participation in the NextGen effort so far. Stakeholders can provide input into NextGen planning through participation in JPDO working groups and the NextGen Institute. JPDO's organizational structure includes nine working groups¹⁴ that were created¹⁵ to bring together federal and nonfederal experts to plan for and coordinate the development of NextGen systems. Similarly, the NextGen Institute was established to incorporate the expertise of industry, state and local governments, and academia into the NextGen planning process. The Institute Management Council, composed of top agency officials and representatives from the aviation community, oversees the policy, recommendations, and products of the institute and provides a means for advancing consensus positions on critical NextGen issues. All of the stakeholders we interviewed, with the exception of stakeholders from an FAA employee union—the Professional Aviation Safety Specialists (PASS)—indicated that they participated in NextGen planning and development activities as members of various JPDO working groups, as members of the Institute Management Council, or by serving as consultants to FAA. Stakeholders from the National Air Traffic Controllers Association (NATCA)—another FAA employee union—indicated that while the union does participate in FAA meetings and briefings related to NextGen, their status is that of a recipient of information rather than an equal party with other stakeholders on the development of NextGen.

While 21 of 22 stakeholders who discussed the issue felt that they were provided the opportunity to participate in NextGen planning, many were not satisfied with the impact of their participation on NextGen planning or with the outcomes of their participation. Some stakeholders said that they frequently attended meetings, but were frustrated by the lack of tangible products being developed and lack of progress being made during these meetings. Thirteen of 15 stakeholders who discussed the issue stated that they did not feel that their level of participation in NextGen allowed for

¹³We interviewed 24 industry stakeholders, but not all individuals responded to all questions.

¹⁴The nine working groups are Airport, Security, Air Navigation Services, Aircraft, Net-centric Operations, Safety, Environment, Weather, and Global Harmonization.

¹⁵The working groups replaced integrated product teams (IPT) in early 2007. The working groups had the same participants as the IPTs, but each working group was led jointly by government and industry. JPDO expected the working groups to be more efficient and output- or product-focused than the IPTs.

sufficient or meaningful input toward decision making. Some stakeholders expressed concern that JPDO and FAA did not include their input in the development of planning documents and other products and that critical issues are not being addressed or incorporated in NextGen plans. In particular, some stakeholders noted that planning documents were drafted by JPDO staff and then provided to them for review and comment. By doing so, one industry stakeholder noted that JPDO was not taking full advantage of their capabilities. Some stakeholders also suggested examining the types of industry players involved with JPDO and how they contribute, indicating that certain types of expertise may not be represented, such as avionics experience.

In addition, a number of stakeholders as well as members of Congress have expressed concerns with the key NextGen planning documents being developed by JPDO and FAA—JPDO's Concept of Operations, Enterprise Architecture, and Integrated Work Plan and FAA's implementation plan for NextGen (a document previously known as the Operational Evolution Partnership (OEP) and now called the NextGen Implementation Plan). Nineteen of 21 industry stakeholders who discussed the issue said that the planning documents lack the information that industry participants need for planning. Many of the stakeholders we interviewed said that while the planning documents provide a high-level view of NextGen benefits, they do not provide specific details such as a catalog of critical needs, clearly defined and prioritized intermediate objectives, and a structured plan for achieving tangible results. According to aviation manufacturing stakeholders, the plans lack specific details to inform them about the type of technology they need to design for NextGen or provide insights to market, build, and install systems that support NextGen. A senior JPDO official noted, however, that the JPDO planning documents were not intended to provide that level of detail. Some industry stakeholders further noted that the current planning does not identify all of the needed research, establish priorities for research and development, or show how to obtain those results. We agree that the latest publicly available versions of these documents lack information that various stakeholders need. For example, the documents do not include key elements such as scenarios illustrating NextGen operations, a summary of NextGen's operational impact on users and other stakeholders, and an analysis of the benefits, alternatives, and trade-offs that were considered for NextGen. However, the next version of the Integrated Work Plan, which JPDO plans to release at the end of September 2008, has schedule information that has been updated to reflect newly available information, coordination with FAA schedule and plans, and revisions in response to public comments received on the previous version, according to JPDO and FAA officials. Our review of the upcoming version—which is an automated, searchable

database—verified that it will have the capability to track dates and identify programs that are behind schedule. In addition, the new version is able to identify programs, policies, or research that must be completed before specific NextGen capabilities can be implemented as well as identify whether industry or a specific federal agency is responsible for completing the action. Agency officials expect subsequent versions of the work plan to include cost information, which we believe will enhance the work plan's usefulness for NextGen oversight.

In addition, a key intended purpose of these planning documents, according to JPDO officials, is to provide the means for coordinating among the partner agencies and private sector manufacturers, aligning relevant research and development activities, and integrating equipment. However, as mentioned previously, 19 of 21 stakeholders who discussed the issue said that the planning documents did not provide guidance for their organizational decision making. For example, some of the stakeholders noted that neither the JPDO planning documents nor FAA's NextGen Implementation Plan provide information on the requirements or specifications needed to develop and manufacture NextGen equipment or anticipate the changes resulting from the implementation of NextGen. As a result, some stakeholders believe that FAA should develop an interim architecture (a technical road map) that provides sufficient detail about what can be accomplished by 2015. This interim document would help bridge the gap between current systems and plans for the future and would help stakeholders plan for the investments that they will need to make in NextGen systems. According to FAA, it has updated its enterprise architecture for the national airspace system and plans to do so annually. According to the agency, the current version of the enterprise architecture reflects NextGen and is being revised to reflect the fiscal year 2009 budget submission and the budget planning time frame of fiscal years 2010 through 2013. However, FAA noted that the level of detail that some stakeholders asked for, such as specifications to develop and manufacture NextGen equipment, will not be available for projects that are still in the concept development and investment analysis phase.

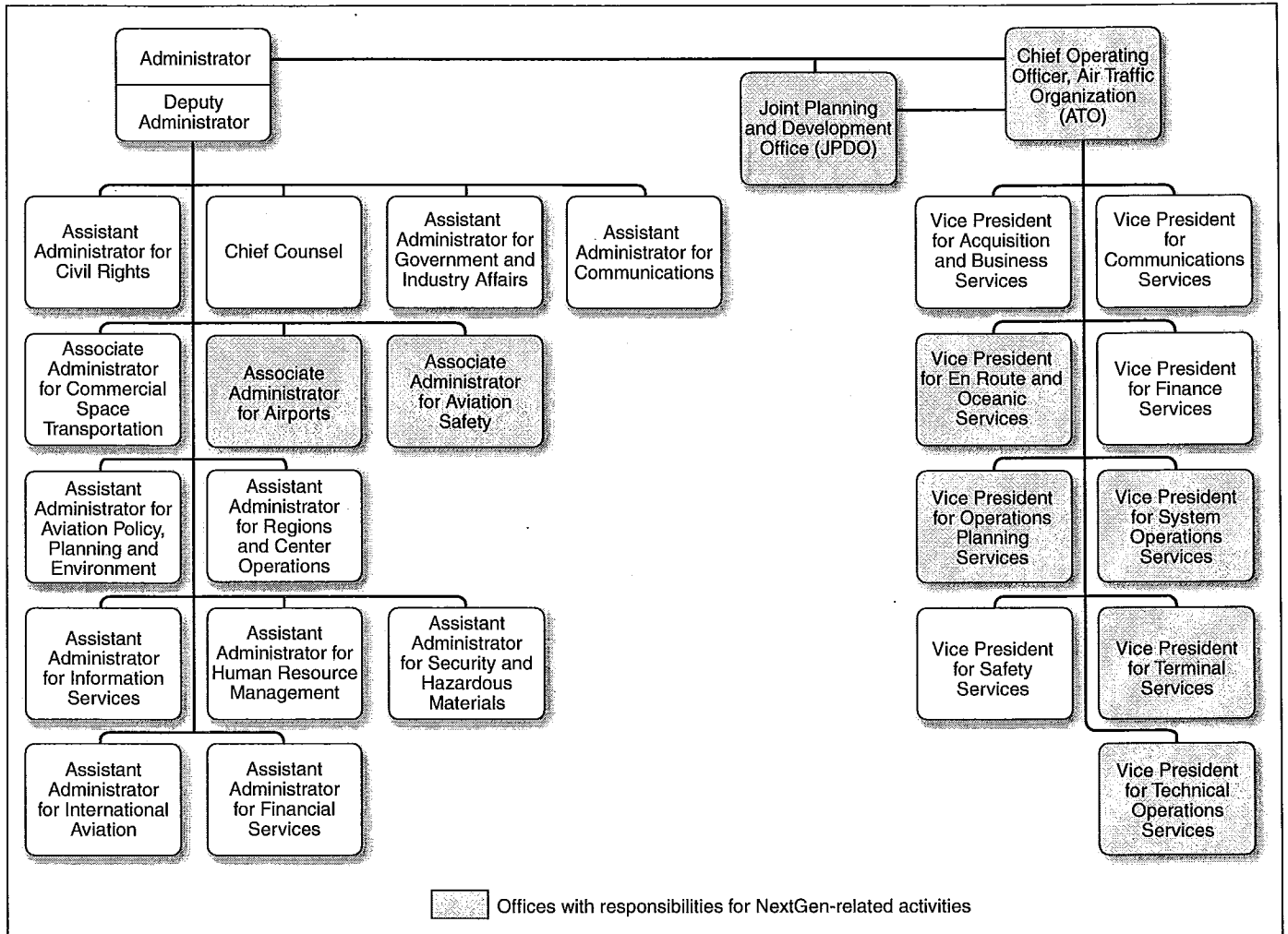
In addition, the Senate Appropriations Committee has expressed concern that the JPDO planning documents lack details on how the various NextGen initiatives will reduce delays and congestion between now and 2025. It would have FAA and JPDO include in future budget justifications and NextGen planning documents a full explanation and quantitative estimate of how much each new capability will reduce congestion, increase capacity, and decrease delays; an explanation of how the data was modeled and compiled; and a time frame for when these capacity

improvements and delay reduction measures will start to relieve congestion.

Stakeholders Have Had Concerns over FAA's Overall Management Structure for NextGen and the Organizational Placement of JPDO

Many stakeholders had concerns about the adequacy of FAA's management structure for NextGen prior to the May 2008 reorganization of ATO, but that reorganization did not address all of their concerns. All 10 stakeholders who discussed the issue viewed FAA's 2007 management structure as not adequate for the transition to NextGen. In addition, 13 of 15 stakeholders who discussed the issue felt that FAA did not have the leadership in place for the transition to NextGen. Prior to May 2008, the executive responsible for developing and overseeing the OEP—FAA's implementation plan for NextGen—was one of nine FAA vice presidents who report to the COO of FAA's ATO, who, in turn, reports directly to the FAA Administrator. Other ATO vice presidents are responsible for NextGen-related activities in their designated areas, such as en route, oceanic, and terminal services. In addition, the FAA executives responsible for airports and aviation safety issues—areas that also encompass NextGen-related activities—are associate administrators who report through the Deputy FAA Administrator to the FAA Administrator. Thus, while some of the activities for which the other vice presidents and associate administrators are responsible are significant to NextGen's implementation, there was no direct line of authority between the Vice President for Operations Planning Services and these activities. Figure 2 shows FAA's management structure as of November 2007.

Figure 2: FAA Organization, November 2007



Source: FAA.

To address the inadequacy they saw in the management structure for NextGen, some stakeholders we spoke with called for the establishment of a NextGen management position or program office that would report directly to the FAA Administrator to ensure accountability for NextGen results. Some of these stakeholders expressed frustration that a program as large and important as NextGen does not follow the industry practice of having one person designated with the authority to make key decisions. They pointed out that although FAA's COO is nominally in charge of FAA's NextGen efforts, the COO must also manage the agency's day-to-day air

traffic operations and may therefore be unable to devote enough time and attention to managing NextGen. In addition, these stakeholders noted that many of NextGen's capabilities span FAA operational units whose heads are at the same organizational level as the Vice President for Operations and Planning Services or are outside ATO all together. Thus, they believed that a position or office above the Vice President for Operations and Planning Services and the other operational units is needed. In prior work, we have found that programs can be implemented most efficiently when managers are empowered to make critical decisions and are held accountable for results.¹⁶

In addition, over the last several years questions have been raised by members of Congress and stakeholders about the appropriateness of JPDO's placement within FAA and its dual reporting to both the FAA Administrator and the COO of ATO. We have reported that JPDO's dual reporting status hinders its ability to interact on equal footing with ATO and other federal agencies.¹⁷ On one hand, JPDO must counter the perception that it is a proxy for ATO and, as such, cannot act as an "honest broker." On the other hand, JPDO must continue to work with ATO and the other federal agencies in a partnership in which ATO is the lead implementer of NextGen. Therefore, we reported that it is important for JPDO to have some independence from ATO and suggested that one change that could begin to address this issue would be to have the JPDO Director report directly to the FAA Administrator. Such a change may also lessen what some stakeholders perceive as unnecessary bureaucracy and red tape associated with decision making and other JPDO and NextGen activities.

In May 2008, FAA announced a reorganization of its NextGen management structure and named a Senior Vice President for NextGen and Operations Planning who reports to the COO. According to ATO's COO, a purpose for the reorganization was to respond to industry stakeholders concerns about the fragmentation of authority over NextGen within FAA by creating one "team"

¹⁶See GAO, *Best Practices: Better Support of Weapon System Program Managers Needed to Improve Outcomes*, GAO-06-110 (Washington, D.C.: Nov. 30, 2005). In this study of private sector best practices that could be applied to federal programs, we found that program managers at highly successful companies were empowered to decide whether programs were ready to move forward and to resolve problems and implement solutions. In addition, program managers were held accountable for their choices.

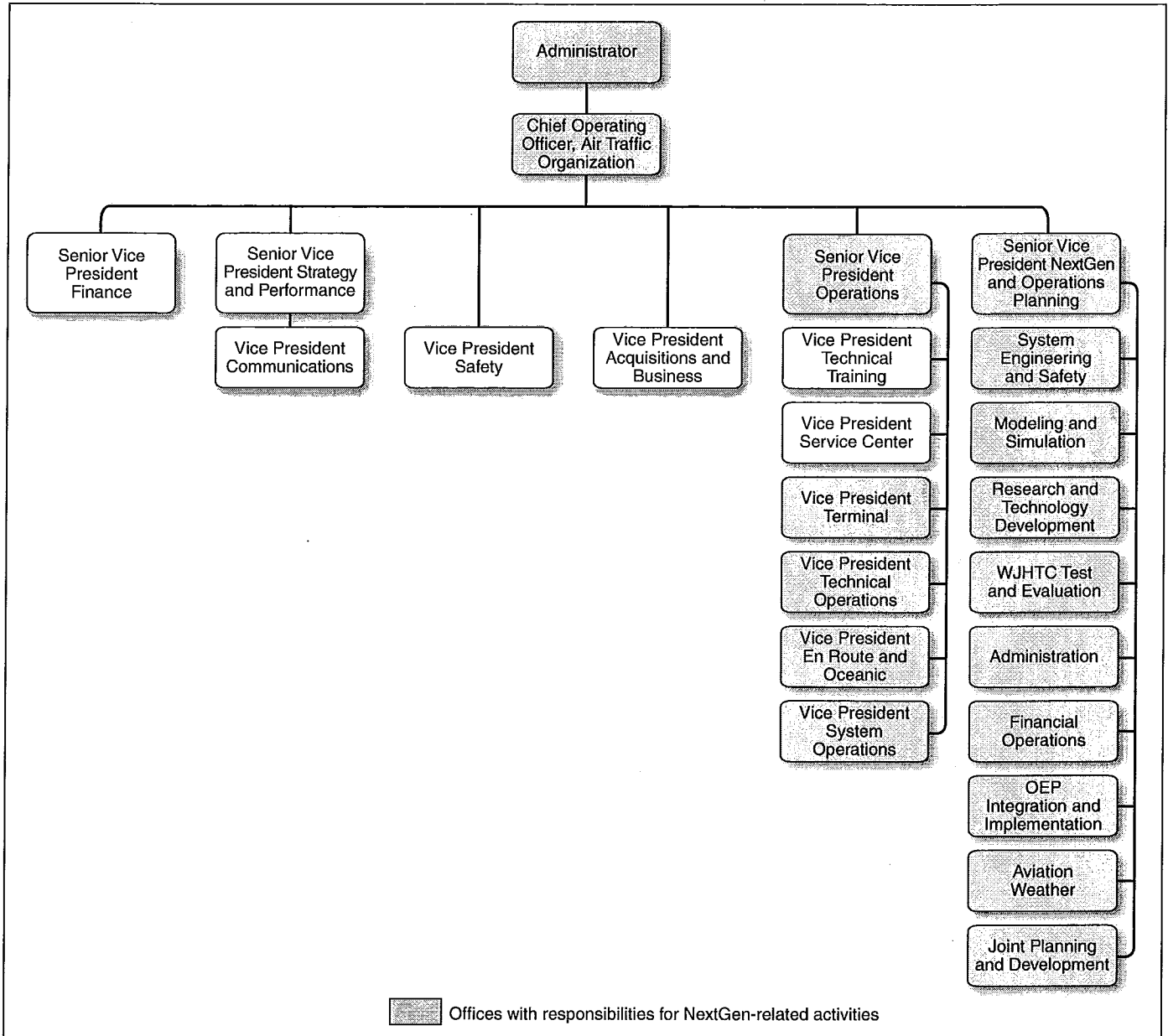
¹⁷GAO, *Responses to Questions for the Record; Hearing on JPDO and the Next Generation Air Transportation System: Status and Issues*, GAO-07-918R (Washington, D.C.: May 29, 2007).

that included NextGen implementation, planning, and oversight with one identified person in charge. According to FAA, the Senior Vice President for NextGen and Operations Planning is responsible for integrating and implementing all elements of NextGen, most of which are executed by other FAA offices within and outside of ATO. The NextGen Senior Vice President also has authority over the allocation of the entire \$5.4 billion NextGen budget requested for fiscal years 2009 through 2013, no matter where that budget is spent within FAA. However, it is too early to tell if this reorganization sufficiently addresses concerns raised by stakeholders about the fragmented management structure for NextGen since other executives continue to have responsibility for parts of NextGen mentioned earlier in this report, and the division of responsibility for NextGen efforts among the senior vice presidents and associate administrators is not clear. A senior FAA executive noted that internal ATO executives are knowledgeable and supportive of the reorganization, but that the agency could better communicate the changes to stakeholders outside of FAA. A focused outreach to industry stakeholders would help to get their buy-in and support of FAA's efforts.

In addition, as part of this reorganization, JPDO is now housed within the new NextGen and Operations Planning Office and reports through the Senior Vice President for Next and Operations Planning only to ATO's COO. Now that JPDO is no longer a separate, independent office within FAA and no longer reports directly to the FAA Administrator, its organizational position within FAA has declined. This placement of JPDO also does not address a concern expressed by eight industry stakeholders who told us that the previous authority structure between FAA and JPDO—with JPDO reporting directly to both the COO and the Administrator—was not adequate for the transition to NextGen. Moreover, proposed legislation reauthorizing FAA would elevate the Director of JPDO to the Associate Administrator for the Next Generation Air Transportation System, appointed by and reporting directly to the FAA Administrator.¹⁸ We believe the proposed legislation comes closer to addressing concerns raised by stakeholders than ATO's action. In addition, the proposed legislation would address observations we have made about JPDO's organizational placement within FAA. (Fig. 3 shows ATO after the May 2008 reorganization.)

¹⁸H.R. 2881, § 202.

Figure 3: ATO Organization, July 2008



Source: FAA.

According to FAA's NextGen Implementation Plan, under this new structure, JPDO will focus on long-term planning and cross-agency cooperation. Other offices within the NextGen and Operations Planning Office will carry out other aspects of implementing and planning for NextGen. It is too early to tell how the reorganization will affect JPDO's overall role or its ability to coordinate and act as an honest broker among the federal partners. According to a senior ATO official, the placement of JPDO with the NextGen and Operations Planning Office was discussed with the NextGen partner federal agencies prior to the announcement of the reorganization, and no objections to the move were expressed.

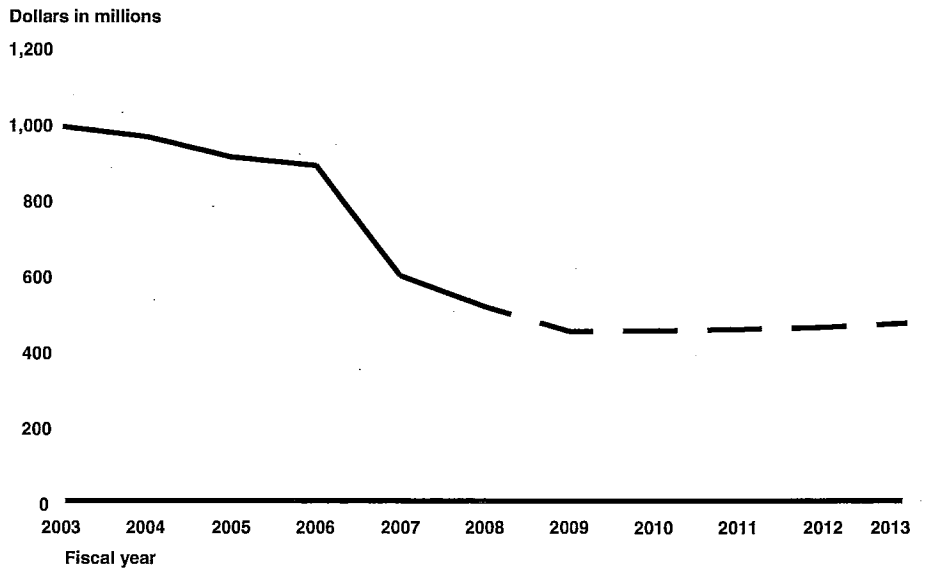
FAA's Ability to Implement and Obtain Expected Benefits from NextGen Will Be Affected by Research and Development, Human Capital, and Infrastructure Challenges

A number of areas are central to FAA's ability to implement NextGen and thus realize the safety and efficiency gains that are expected for the nation's air transportation system. Applied research and development are important for implementation because they will help to reduce risk by better defining and demonstrating new capabilities, setting parameters for the certification of new systems, and informing decisions about the later transfer of systems to industry for deployment into the national airspace system. However, it is uncertain which entities will fund and conduct the research and development needed for NextGen. The research and development of some new technologies and procedures have reached the point in which they can be demonstrated in the national airspace. FAA has only recently initiated a project to deploy available NextGen technologies simultaneously in Florida to better demonstrate their capabilities and interrelationships. In addition, a human capital challenge to FAA's implementation of NextGen will be having personnel with the appropriate knowledge, skills, and training. Furthermore, to fully realize NextGen capabilities, a new configuration of ATC facilities and enhanced runway capacity will be required.

Research and Development Funding Uncertainties and Research Gaps Exist

In the past, NASA performed a significant portion of aeronautics research and development. However, NASA's aeronautics research budget has been declining since the mid-1990s. As shown in figure 4, NASA's aeronautics research budget declined from about \$959 million in 2004 to \$511 million in 2008. While NASA still plans to focus some of its research on NextGen needs, the agency has moved toward a focus on fundamental research and away from developmental work and demonstration projects. As a result, in some cases, NASA's research focuses on developing technologies to a lower—and therefore less readily adopted—maturity level than in the past. According to NASA officials, about \$280 million of its proposed \$447 million aeronautics research budget proposed for fiscal year 2009 would contribute to NextGen efforts. Ten industry stakeholders told us that the "research gap" left by NASA's declining aeronautics research budget needs to be addressed.

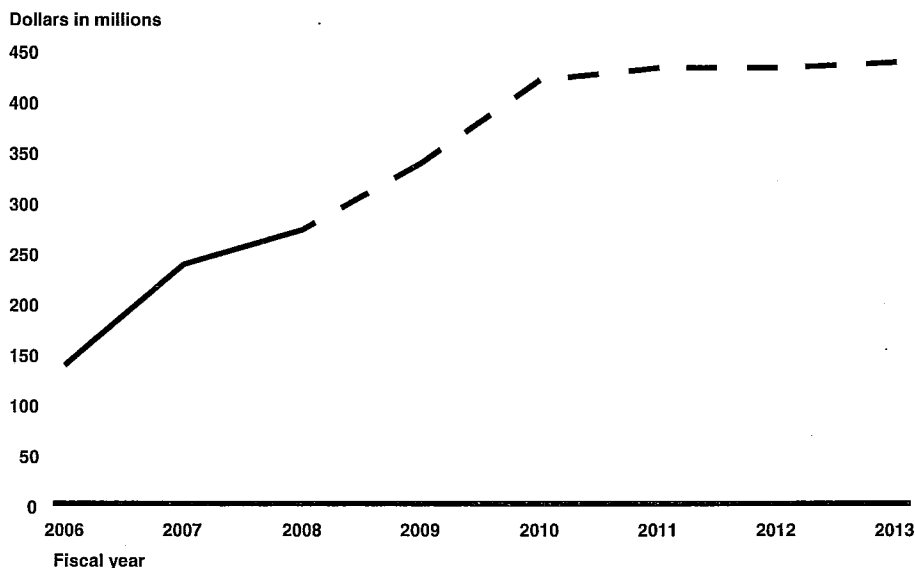
Figure 4: NASA's Aeronautics Research Budget for Fiscal Years 2003 through 2008 and Proposed Budget through Fiscal Year 2013, in Constant 2008 Dollars



Source: GAO analysis.

FAA has also determined that research gaps now exist as a result of both the administration's cuts to NASA's aeronautics research funding and the expanded requirements of NextGen. Budget requests for FAA have increased to help provide the needed research and development funding for NextGen. According to FAA, the agency will spend an estimated \$740 million on NextGen-related research and development during fiscal years 2009 through 2013. The administration's proposed budget for fiscal year 2009 requests \$56.5 million for FAA research and development to support the integration and implementation of NextGen programs, a substantial increase over the \$24.3 million authorized for fiscal year 2008. The actual and projected increases in FAA's overall research and development funding (see fig. 5) reflect the expected increases in NextGen research funding.

Figure 5: FAA's Overall Research and Development Funding for Fiscal Years 2006 through 2008 and Proposed Funding through Fiscal Year 2013, in Constant 2008 Dollars



Source: GAO analysis.

One critical area in which a research and development gap has been identified is the environmental impact of aviation. According to a JPDO analysis, environmental impacts will be the primary constraint on the capacity and flexibility of the national airspace system unless these impacts are managed and mitigated. In proposed legislation reauthorizing FAA, \$111 million for fiscal years 2009 through 2011 may be used for a new FAA program to help close the research and development gap and reduce aviation noise and emissions.¹⁹ This program—the Continuous Lower Energy, Emissions, and Noise (CLEEN) initiative—would facilitate over the next 10 years the development, maturation, and certification of improved airframe technologies. The CLEEN program, in which NASA would participate as an adviser, is intended to address the gap between NASA's fundamental research in noise reduction and the need for near-term demonstrations of technology. The program would establish a research consortium of government, industry, and academic participants

¹⁹H.R. 2881, § 505.

that would allow for the maturation of these technologies via demonstration projects.²⁰

Our work indicates that a research gap also exists in the area of human factors research. Human factors research explores what is known about people and their abilities, characteristics, and limitations in the design of the equipment they use, the environments in which they function, and the jobs they perform. Seven of eight stakeholders that discussed the issue expressed concern that NextGen plans do not adequately address human factors research. For example, a central assumption of the NextGen system is an increased reliance on automation, which dramatically changes the roles and responsibilities of both air traffic controllers and pilots. These changes in roles and responsibilities raise significant human factors issues for the safety and efficiency of the national airspace system. According to an FAA official, verbal communication is an example of a human factors area that requires further research and development. Currently, air traffic controllers primarily rely on verbal communication to direct aircraft. Because NextGen will rely more on data link and other automated communications, controllers will require training in both understanding and operating in an automated communications environment. The research to support such training has not been conducted, according to FAA.²¹ FAA plans to invest \$180.4 million in human factors research from fiscal year 2009 to fiscal year 2013. Furthermore, NASA recently adjusted the size of its human factors research staff starting in fiscal year 2005, reassigning some staff to other programs and reducing the contractor and academic technical support for human factors research. However, according to NASA, human factors research continues to be a critical component of its aeronautics research program, with activity focused at the foundational level. It remains to be seen if FAA's planned research and development in this area will offset NASA's reductions, since FAA's research is typically at a more applied level.

To help bridge the gap between NASA's research and FAA's need to develop and implement new technology, the two agencies have developed a strategy to identify, conduct, and transfer to FAA the research and

²⁰GAO, *Aviation and the Environment: FAA's and NASA's Research and Development Plans for Noise Reduction Are Aligned but the Prospects of Achieving Noise Reduction Goals Are Uncertain*, GAO-08-384 (Washington, D.C.: Feb. 15, 2008).

²¹FAA agreed with this statement, but noted that significant research on the use of data link and other automated communications has been conducted by FAA and others for the en route environment.

development needed for NextGen. The strategy initially establishes four “research transition teams”²² that align with JPDO’s planning framework and outlines how the two agencies will jointly develop research requirements—FAA will provide user requirements, and NASA will conduct the research and provide an understanding of the engineering rationale for design decisions. In addition, the strategy calls for defining metrics for evaluating the research. According to JPDO, as of August 2008, the four teams had been established and held initial meetings. While these developments are positive steps, it is too early to tell if they will be effective in addressing NextGen’s overall research needs. Unless NextGen’s developmental research needs are met in a timely manner, the implementation of NextGen is also likely to be delayed, jeopardizing NextGen’s goals of increased safety, efficiency, and capacity of the system.

FAA and NASA have worked to identify the research and development that is needed for NextGen, including research on aviation’s impact on the environment and human factors research, and have prioritized their individual research portfolios. However, JPDO has not yet determined what NextGen research and development needs to be done first and at what cost to demonstrate and integrate NextGen technologies into the national airspace system. JPDO’s prioritization of research needs is an essential step in identifying the resources required to undertake needed research and development. One stakeholder suggested a risk-based approach to prioritization. Prioritization of research is critical to avoid spending limited funds on lower-priority efforts or conducting work out of sequence. As mentioned previously in this report, the next version of the Integrated Work Plan, scheduled to be released in September 2008, will be able to identify the sequencing of research that must be completed before specific NextGen capabilities can be implemented. This should provide a useful tool in prioritizing and tracking NextGen research.

Regional Demonstrations Could Accelerate Integration and Adoption of NextGen Technologies

Some stakeholders are concerned that although new technologies and procedures are being researched and developed, they are not being implemented as quickly as needed to reach the goal of having NextGen in place by 2025. Thirteen industry stakeholders told us that technologies are available now that should be used immediately. Among the NextGen technologies and procedures that are already available, FAA has implemented a few individually, such as Continuous Descent Arrival

²²The four teams are organized along the framework for near-, mid-, and long-term research goals established in JPDO’s Integrated Work Plan. The teams are Separation Management, Trajectory Management, Flow Contingency Management, and Capacity Management.

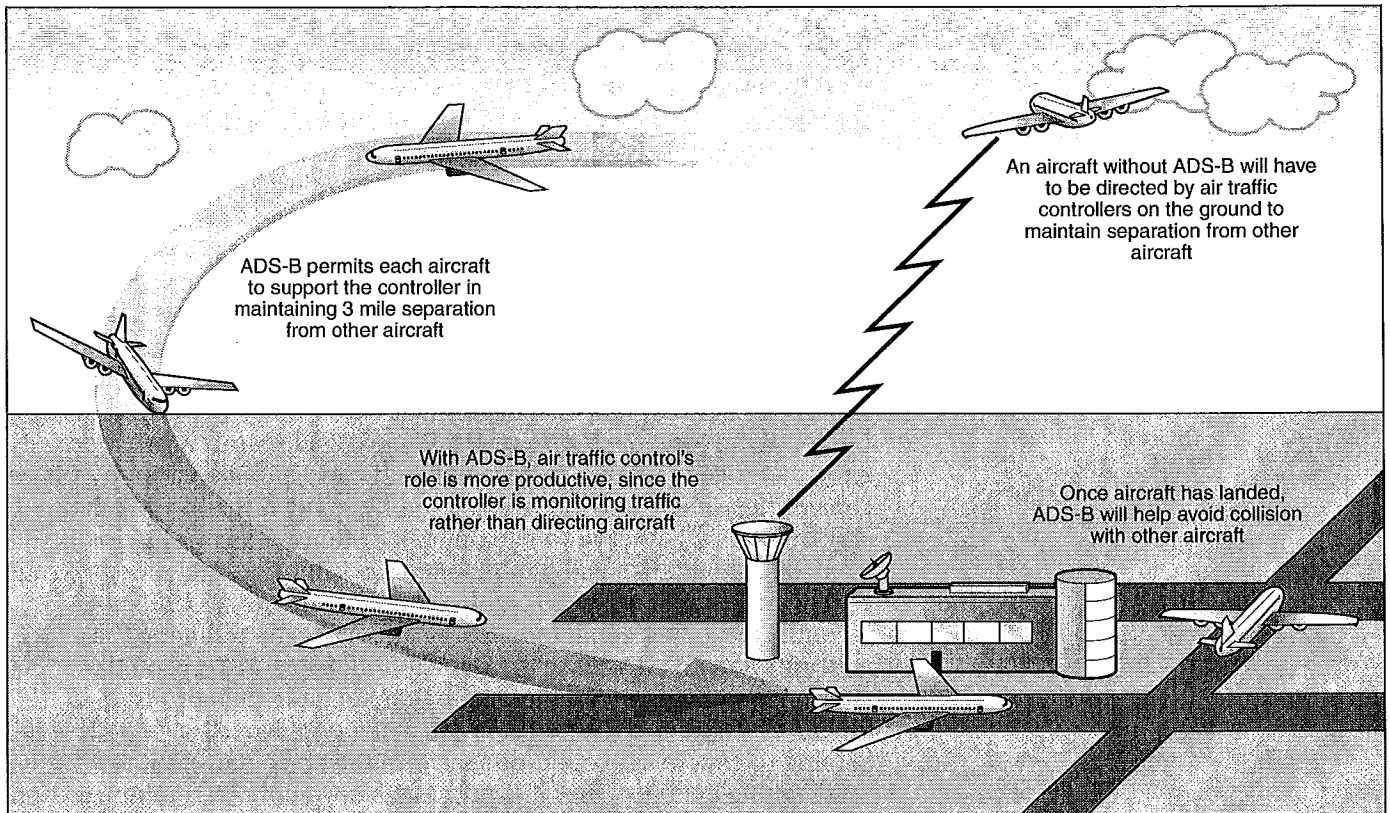
(CDA)²³ procedures in use in Los Angeles and Louisville and Automatic Dependent Surveillance-Broadcast (ADS-B)²⁴ in Alaska. In addition, FAA is working with a few airlines, such as United Parcel Service (UPS), which is installing ADS-B on all of its Boeing 757 and 767 aircraft. The equipment will record and transmit each aircraft's speed, heading, altitude, and global positioning system coordinates to all other aircraft similarly equipped, allowing each to map the traffic around it. With fleetwide equipage of ADS-B, carriers such as UPS may be able to increase landing rates enough to justify the equipage costs, according to an aviation research organization. (Fig. 6 shows examples of ADS-B in use.) In past work, we have reported that available NextGen technologies and procedures have not yet been deployed simultaneously to demonstrate that they can be operated safely as an integrated suite of technologies and procedures in the national airspace system.²⁵

²³CDA allows aircraft to remain at cruise altitudes longer as they approach destination airports, use lower power levels, and thereby lower emissions and noise during landings.

²⁴ADS-B is a satellite aircraft navigation system that is designed, along with other navigation technologies, to enable more precise control of aircraft during en route flight, approach, and descent.

²⁵GAO, *Aviation and the Environment: NextGen and Research and Development Are Keys to Reducing Emissions and Their Impact on Health and Climate*, GAO-08-706T (Washington, D.C.: May 6, 2008).

Figure 6: Example of Use of ADS-B



Source: GAO.

Eleven of 12 stakeholders who discussed the issue suggested that FAA consider a gradual rollout of NextGen technologies and procedures in a designated area. For example, ADS-B technologies; CDA, Area Navigation (RNAV) and Required Navigation Performance (RNP) procedures;²⁶ and high-density airport operations could be deployed in a defined location, possibly in sequence over time, to test their combined use and demonstrate the safety and efficiency of an integrated suite of NextGen

²⁶RNAV equipment can compute an airplane's position, actual track, and ground speed, and then provide meaningful information on the route of flight selected by the pilot. RNP will permit the airplane to descend on a precise route that will allow it to avoid populated areas, reduce its consumption of fuel, and lower its emissions of carbon dioxide and nitrogen oxides.

advancements. Such a graduated rollout is sometimes referred to as “NextGen lite.”

Along these lines, in June 2008, FAA signed a memorandum of agreement with the state of Florida and DayJet—a carrier that provides air taxi²⁷ service—to establish a government and industry partnership for demonstrating NextGen technologies prior to national implementation. For the Florida demonstration, FAA, together with aviation equipment manufacturers and municipalities, will use the NextGen capabilities of ADS-B, RNAV, and RNP for an on-demand air taxi fleet’s operations. As other NextGen capabilities, such as System-Wide Information Management (SWIM),²⁸ are deployed and if the air taxi fleet’s operations move to other airports and regions, the demonstration is expected to be expanded to include those new capabilities and other airports and regions. In addition, in June 2008, FAA signed an agreement with Embry-Riddle Aeronautical University to Support future research and demonstrations that are expected to lead to proof of concept and early implementation of NextGen capabilities, according to FAA. According to the airlines and other stakeholders we interviewed, a demonstration of the integration of NextGen capabilities and of efficiencies resulting from their use would give airlines an incentive to equip their aircraft with NextGen technologies. They could then lower their costs by reducing their fuel consumption and decrease the impact of their operations on the environment. Our research indicate that such regional or targeted demonstrations could accelerate the delivery of NextGen benefits while helping to ensure safe operations within the current system. By establishing benefits early in a program’s development, demonstrations can increase stakeholders’ confidence in the overall NextGen initiative and provide incentives for the aviation community to equip aircraft with compatible technology.

NextGen Will Require New Skills and Abilities of FAA Personnel

FAA will need technical skills such as systems engineers and contract management expertise to implement NextGen. Because of the scope and complexity of the NextGen effort, the agency may not currently have the in-house expertise to manage the transition to NextGen without

²⁷Air taxis are small aircraft that can be hired to provide per-seat, point-to-point air transportation service, either on demand or on scheduled flights.

²⁸SWIM is information management architecture for the national airspace system, acting as its “World Wide Web.” SWIM will manage surveillance, weather, and flight data, as well as aeronautical and system status information, and will provide the information securely to users.

assistance. In November 2006, we recommended that FAA examine its strengths and weaknesses with regard to the technical expertise and contract management expertise that will be required to define, implement, and integrate the numerous complex programs inherent in the transition to NextGen.²⁹ In response to our recommendation, FAA contracted with NAPA to determine the mix of skills and number of skilled persons, such as technical personnel and program managers, needed to implement NextGen and to compare those requirements with FAA's current staff resources. In December 2007, NAPA provided FAA with its report on the types of skills that will be needed by FAA.³⁰ NAPA has undertaken a second part of the study to identify skill gaps between FAA's current staff and the staff that would be required to implement NextGen. NAPA officials told us that they expect to publish the findings of the second part of the study in September 2008. We believe that this is a reasonable approach that should help FAA begin to address this issue, recognizing that once the right skill set is identified, it may take considerable time to select, hire, and integrate what FAA estimates could be 150 to 200 more staff. This situation has the potential to contribute to delays in integrating new technologies and transforming the national airspace system.

In addition, the implementation of NextGen will involve training personnel across FAA as new systems are brought online. NextGen entails an increased reliance on automation and changing roles for both air traffic controllers and pilots. In such an automated environment, some of the responsibilities of controllers will shift from air traffic control to air traffic management,³¹ and pilots will take on a greater share of the responsibility for maintaining safe separation between aircraft and other tasks currently performed by controllers. FAA's air traffic controllers and repair technicians will have to be trained to operate and maintain both the old and new systems as new technologies are gradually brought online. While 15 stakeholders told us that it was too early to begin training for new systems that are not close to deployment, 4 stakeholders who represent

²⁹GAO, *Next Generation Air Transportation System: Progress and Challenges Associated with the Transformation of the National Airspace System*, GAO-07-25 (Washington, D.C.: Nov. 13, 2006).

³⁰National Academy of Public Administration, *Workforce Needs Analysis for the Next Generation Air Transportation System (NEXTGEN): Preliminary Findings and Observations* (Washington, D.C.: December 2007).

³¹With current air traffic control, controllers handle individual planes through various phases of flight. Under air traffic management, controllers would likely oversee a greater number of planes but with less direct communication with each pilot. Controllers would monitor air traffic as a whole and intervene when necessary to avoid problems.

groups that would be using the new systems or teaching those users said that now was the time to begin developing the training to prepare FAA personnel and others for the changing operating procedures that will occur under NextGen. For example, one stakeholder noted that the educational community needs to be engaged now so that it can be prepared to teach future air traffic controllers and pilots. Another stakeholder believed that during the transition to NextGen, FAA would need training capabilities at each ATC facility for air traffic controllers who may be using both NextGen systems and legacy systems. While FAA believes that it is too early to begin such training, according to the agency, it began a strategic job analysis in fiscal year 2008 to determine how the controller's job will change as a result of NextGen. In fiscal year 2009, the agency plans to conduct a strategic training analysis to identify training for controllers that will be needed to address those job changes.

**Facilities and Airport
Limitations Present
Challenges to
Realizing the Full Potential
of NextGen**

To fully realize all of NextGen's capabilities, a new configuration of ATC facilities and enhanced runway capacity will be required. According to a senior ATO official, the agency plans to report on the cost implications of reconfiguring its facilities in 2009. However, FAA has not developed a comprehensive plan to reconfigure its facilities. Until the cost analysis is completed and the reconfiguration plan has been developed, the configurations needed for NextGen cannot be implemented and potential savings that could help offset the cost of NextGen will not be realized. Some FAA officials have said that planned facility maintenance and construction based on the current ATC system are significant cost drivers that could, without reconfiguration, significantly increase the cost of NextGen.

In the meantime, FAA faces an immediate task to maintain and repair existing facilities so that the current ATC system continues to operate safely and reliably. The agency is currently responsible for maintaining over 400 terminal facilities. While FAA has not assessed the physical condition of all of these facilities, the agency rated the average condition of 89 of them as "fair," with some rated "good" and others "very poor." Based on its assessment of these 89 facilities, FAA estimated that a onetime cost of repair to all of its terminal facilities would range from \$250 million to \$350 million. Two FAA employee unions (NATCA and PASS) contend that these facilities are deteriorating because of lack of maintenance and that working conditions are unsafe because of leaking roofs, deteriorating walls and ceilings, and obsolete air-conditioning systems. According to FAA officials, while some of these facilities can accommodate the new technologies and systems of NextGen, many of them are not consistent with the configurations that will be needed under

NextGen. Once FAA develops a facility reconfiguration plan that identifies facilities for consolidation, the costs of repairing and maintaining its facilities may be reduced. In the meantime, FAA will have to manage its budgetary resources so that it can maintain legacy systems and legacy infrastructure while configuring the national airspace system to accommodate NextGen technologies and operations.

With regard to airport infrastructure, a transition to NextGen will also depend on the ability of airports to handle greater capacity. One way that FAA is endeavoring to increase airport runway capacity is its High-Density Terminal and Airport Operations initiative, which the agency has just begun to implement. Under this initiative, aircraft arriving and departing from different directions would be assigned to multiple runways and safely merged into continuous flows despite bad weather and low visibility. To guarantee safe separation between aircraft, these airports would need enhanced navigation capabilities and controllers with access to increased automation. Under this initiative, aircraft would also move more efficiently on the ground, using procedures that are under development to reduce spacing and separation requirements and improve the flow of air traffic into and out of busy metropolitan airspace. Although the implementation of this initiative is in the early stages, FAA has identified the research and development needed to move it forward. FAA has also identified runway safety technologies for accelerated implementation.

The increases in capacity expected from the High-Density Terminal and Airport Operations initiative are not likely to be sufficient to handle the expected increases in traffic. As a result, new or expanded runways will likely be needed. FAA has developed a rolling 10-year plan for capacity improvements at the nation's 35 busiest airports, and some airports are building new runways. Moreover, FAA simulated the expected capacity enhancement of these currently planned runway improvements and the additional capacity gained through the implementation of some NextGen initiatives³² and found that by 2025, 14 airports will still need additional capacity. In addition, building new runways at some of these airports will present considerable obstacles. The 14 airports are as follows:

- Fort Lauderdale-Hollywood International
- Hartsfield-Jackson Atlanta International

³²The NextGen concepts that were included in the simulation included revised separation standards, independent operations on closely spaced parallel runways, reduced in-trail wake vortex separation requirements, and the use of equivalent visual techniques.

-
- John F. Kennedy International
 - John Wayne-Orange County
 - LaGuardia
 - Long Beach-Daugherty Field
 - McCarran International
 - Metropolitan Oakland International
 - Midway
 - Newark Liberty International
 - Philadelphia International
 - Phoenix Sky Harbor International
 - San Diego International
 - San Francisco International

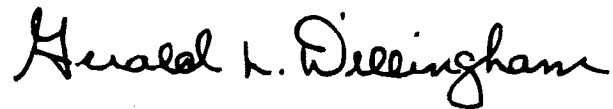
In part, as a result of the continuing need for runway development, some of the planning for NextGen includes reducing the environmental impact of aviation because of local community concerns about aviation emissions and noise. Thirteen industry stakeholders view community opposition to the environmental impacts of aviation as a key issue affecting the success of NextGen. Furthermore, state and local governments play a large role in providing needed support for expanding airport capacity for the national air transportation system. Without significant reductions in emissions and noise around the nation's airports and continuing efforts at all levels of government, efforts to expand airport capacity could be stalled and the implementation of NextGen delayed.

Agency Comments

We provided a draft of this report to DOT and NASA for their review and comments. Both agencies provided technical clarifications, which we incorporated into this report as appropriate.

We are sending copies of this report to the Secretaries of Transportation, Defense, Commerce, and Homeland Security and the Administrators of NASA and FAA. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or dillingham@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix V.



Gerald L. Dillingham, Ph.D.
Director, Physical Infrastructure Issues

List of Requesters

The Honorable Bart Gordon
Chairman

The Honorable Ralph Hall
Ranking Member
Committee on Science and Technology
House of Representatives

The Honorable John Mica
Ranking Republican Member
Committee on Transportation and Infrastructure
House of Representatives

The Honorable John D. Rockefeller, IV
Chairman

The Honorable Kay Bailey Hutchison
Ranking Member
Subcommittee on Aviation Operations, Safety, and Security
Committee on Commerce, Science, and Transportation
United States Senate

The Honorable Jerry F. Costello
Chairman

The Honorable Thomas Petri
Ranking Republican Member
Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

Appendix I: Scope and Methodology

In this report, we assessed the Federal Aviation Administration's (FAA) ability to acquire and integrate new air traffic control (ATC) systems and transition to the next generation air transportation system (NextGen). Specifically, we established the following research questions: (1) What are the status and outcome of FAA's ATC systems acquisition activities? (2) What is the status of the key NextGen planning and transition issues? (3) What key challenges does FAA face in implementing NextGen?

To determine the status and outcome of FAA's ATC systems acquisition activities, we updated acquisition baseline information on cost and schedule and we summarized our recent work on acquisition performance.¹ To determine FAA's Air Traffic Organization's (ATO) progress in acquisitions management, we analyzed the trends for budget and schedule outcomes between the original baselines and current budget and schedule baselines for the acquisitions that ATO selected for performance reporting and monitoring from fiscal years 2004 through 2008. We also drew upon past work in which we undertook detailed reviews of the status of ATC acquisition programs, and obtained updated information as necessary from FAA by reviewing documents and interviewing agency officials. Through discussions with ATO officials, we determined that these data were sufficiently reliable for the purposes of our report.

To determine the status of the key NextGen planning and transition issues and key challenges facing FAA in implementing NextGen, we interviewed senior ATO and Joint Planning and Development Office (JPDO) officials. We also reviewed relevant literature and JPDO publications, including JPDO's Concept of Operations, Enterprise Architecture, and Integrated Work Plan, and previous GAO reports on NextGen. In addition, we obtained the views of key nonfederal aviation stakeholders involved with NextGen and JPDO on the progress of, and challenges to achieving and planning for, the transition to NextGen. We identified those key stakeholders who, by virtue of their positions, possessed special knowledge that they were willing to share with us through formal interviews. We selected a sample of 24 key stakeholders from various categories of the community of aviation stakeholders. Within the categories (e.g., manufacturers, operators, airports, air traffic controllers, pilots, and academia) we balanced the selection of stakeholders to capture

¹GAO, *Air Traffic Control: FAA Reports Progress in System Acquisitions, but Changes in Performance Measurement Could Improve Usefulness of Information*, GAO-08-42 (Washington, D.C.: Dec. 18, 2007).

the views of the different stakeholder categories. The key stakeholders were representatives from the following organizations:

- Aerospace Industries Association of America
- American Association of Airport Executives
- Airports Council International – North America
- Airbus
- Air Line Pilots Association
- Aircraft Owners and Pilots Association
- Air Transport Association
- Air Traffic Control Association
- Boeing Company
- Cargo Airline Association
- Embry-Riddle Aeronautical University
- Flight Safety Foundation
- General Aviation Manufacturers Association
- Honeywell
- ITT Corporation
- Lockheed-Martin
- National Association of State Aviation Officials
- National Air Traffic Controllers Association
- National Business Aviation Association
- Professional Aviation Safety Specialists
- Regional Airline Association
- Raytheon
- Rockwell-Collins
- RTCA (formerly known as the Radio Technical Corporation of America)

We conducted the stakeholder interviews using open-ended questions arranged by topics with standard probe notes to help ensure consistent results. The topics included stakeholder participation in NextGen, JPDO activities, the transition to NextGen, training, environmental issues, and research and development. With the permission of stakeholders, we recorded the interviews and had them professionally transcribed. The information contained in the transcripts was analyzed and coded into response categories for each topic. A reviewer checked the resulting categories and coded responses and, when interpretations differed, agreement was reached between the initial coder and the reviewer. The result of this content analysis is found in appendix II.

We then obtained further information related to the stakeholder responses by conducting interviews with representatives of relevant NextGen partner agencies—JPDO, FAA, and the National Aeronautics and Space

Administration (NASA). We also obtained and reviewed relevant documentation from these agencies, including research and development budget documents from FAA and NASA. We did not obtain further information from the other federal partners—the Departments of Commerce, Defense, and Homeland Security and the White House Office of Science and Technology Policy—because the stakeholders did not articulate issues related to those agencies. We also interviewed representatives from the National Academy of Public Administration to obtain information on their work related to FAA’s skill needs for NextGen. In addition, we summarized information on NextGen environmental issues from our recent report and testimony.²

We conducted our performance audit from July 2007 to September 2008 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.

²GAO, *Aviation and the Environment: FAA’s and NASA’s Research and Development Plans for Noise Reduction Are Aligned but the Prospects of Achieving Noise Reduction Goals Are Uncertain*, GAO-08-384 (Washington, D.C.: Feb. 15, 2008), and *Aviation and the Environment: NextGen and Research and Development Are Keys to Reducing Emissions and Their Impact on Health and Climate*, GAO-08-706T (Washington, D.C.: May 6, 2008).

Appendix II: Stakeholder Responses to Semistructured GAO Interview Questions

Interview topics and answer categories	Number of stakeholders responding		
	Yes	No	Indecisive or no response
Stakeholder participation			
Opportunity to participate	21	1	2
Participation involved input to decision making	2	13	9
Satisfaction with the amount of participation	7	14	3
Views on NextGen			
Presents a vision of high-level goals	15	2	7
Presents a programmatic path to high-level goals	0	23	1
Agreement that NextGen will reduce congestion	10	5	9
Congressional actions are needed for the transition to NextGen	18	1	5
JPDO planning documents			
Have been reviewed by the individual or organization	22	0	2
Useful for organizational or individual decision making	2	19	3
Understood by policymakers	1	8	15
JPDO achievements			
Provided a vision of a high-level end state	13	6	5
Developed planning documents for NextGen	16	2	6
Coordinated multiagency efforts	5	3	16
Avionics equipage			
Advantages of incentives mentioned	17	1	7
Advantages of mandates mentioned	12	5	7
Organization has made plans or investments to accommodate need for avionics equipage	8	7	9
Training			
Is an issue to be considered at some point, but it is too soon to take definite steps to address	15	1	7
Is an issue that can be addressed immediately	4	0	21
Environmental issues			
Noise is a key issue affecting the success of NextGen	16	1	7
Emissions are a key issue affecting the success of NextGen	17	0	7
Water pollution is a key issue affecting the success of NextGen	3	0	21
Construction of buildings and runways are key issues affecting the success of NextGen	13	0	11
Community opposition to the environmental impact of aviation is a key issue affecting the success of NextGen	13	0	11
Transition to NextGen			
FAA has adequate expertise available for the transition	4	10	10

**Appendix II: Stakeholder Responses to
Semistructured GAO Interview Questions**

Interview topics and answer categories	Number of stakeholders responding		
	Yes	No	Indecisive or no response
FAA needs a "lead systems integrator" for the transition	3	3	18
JPDO has the expertise available to help in the transition	5	8	11
Governance structure for NextGen			
Current Operational Evolution Partnership (OEP) organization adequate for the transition	0	10	14
JPDO's authority is adequate for its planning and coordination function	3	8	13
FAA currently has the leadership in place for the transition to NextGen	3	13	8
FAA, JPDO, and OEP have the leadership team needed for the transition to NextGen	0	8	16
The authority structure between FAA and JPDO is adequate for the transition to NextGen	0	8	16
Research and development			
The "research gap" needs to be addressed	10	0	14
Current plans and implementing operations do not adequately address human factors	7	1	16
Technologies are available that should be used immediately	13	0	11
Demonstrations, including regional implementation of technology, are needed	11	1	12

Source: GAO.

Appendix III: ATC Acquisition Performance

(Dollars in millions)

Program	Baseline status as of February 2004		Estimate at completion as of June 2008		Variances	
	Cost	Schedule duration in months	Cost	Schedule duration in months	Cost variance	Schedule variance in months
Free Flight Phase 2 Traffic Management Advisor - Single Center	\$135.5	55	\$135.5	64	\$0.0 (0.0%)	(9) (16.4%) behind schedule
Airport Surface Detection Equipment – Model X	424.3	108	550.1	118	(44.9) (8.9%) over budget	(10) (2.4%) behind schedule
Airport Surface Detection Equipment - Model X Upgrade Sites with Multilateration	80.9	79				
Air Traffic Control Beacon Interrogator Replacement	282.9	90	255.1	142	27.8 (9.8%)	(52) (57.8%) behind schedule
En Route Automation Modernization	2,154.6	90	2,154.6	90	0.0 (0.0%)	0 (0.0%)
FAA Telecommunications Infrastructure	310.2	102	318.8	114	(8.6) (2.8%) over budget	(12) (11.8%) behind schedule
Next Generation Air-to-Ground Communication System Segment 1a	318.4	124	324.7	160	(6.3) (2.0%) over budget	(36) (29.0%) behind schedule
Standard Terminal Automation Replacement System	2,769.5	135	2,719.2	135	50.3 (1.8%)	0 (0.0%)
Wide Area Augmentation System	3,339.6	55	3,339.6	55	0.0 (0.0%)	0 (0.0%)
Airport Surveillance Radar - Model 11	916.2	172	696.5	157	219.7 (24.0%)	15 (8.7%)
Aviation Surface Weather Observation Network	403.8	218	384.3	254	19.5 (4.8%)	(36) (16.5%) behind schedule
Integrated Terminal Weather System	286.1	147	286.1	147	0.0 (0.0%)	0 (0.0%)

Appendix III: ATC Acquisition Performance

Program	Baseline status as of February 2004		Estimate at completion as of June 2008		Variances	
	Cost	Schedule duration in months	Cost	Schedule duration in months	Cost variance	Schedule variance in months
FSAS Operational and Supportability Implementation System	249.4	101	169.0	91	80.4 (32.2%)	10 (9.9%)
National Airspace System Infrastructure Management System-Phase 2	90.2	76	90.2	90	0.0 (0.0%)	(14) (18.4%) behind schedule
ASR-9 / Mode S SLEP Phase 1A External Modifications	14.3	52	15.5	38	(1.2) (8.4%) over budget	14 (26.9%)
ASR-9 / Mode S SLEP Phase 1B Transmitter Modifications	57.9	65	57.9	65	0.0 (0.0%)	0 (0.0%)
Instrument Flight Procedures Automation	50.8	60	50.8	60	0.0 (0.0%)	0 (0.0%)
Terminal Automation Modernization Replacement	139.5	29	139.5	29	0.0 (0.0%)	0 (0.0%)
Voice Switch and Control System Tech Refresh Phase 2	83.8	70	83.8	70	0.0 (0.0%)	0 (0.0%)
Automatic Dependent Surveillance Broadcast Segments 1 & 2	1,678.2	85	1,678.2	85	0.0 (0.0%)	0 (0.0%)
Traffic Flow Management-Infrastructure	398.1	56	398.1	56	0.0 (0.0%)	0 (0.0%)
System-Wide Information Management	96.6	39	96.6	39	0.0 (0.0%)	0 (0.0%)
Terminal Doppler Weather Radar SLEP	55.4	77	55.4	77	0.0 (0.0%)	0 (0.0%)
Ultra High Frequency Replacement	85.1	94	85.1	130	0.0 (0.0%)	(36) (38.3%) behind schedule
En Route Control Center System Modernization	201.9	69	167.9	45	34.0 (16.8%)	24 (34.8%)
Voice Recorder Replacement Program Next Generation	48.1	80	48.1	80	0.0 (0.0%)	0 (0.0%)
Total	\$14,671.3	2,328	\$14,300.6	2,391	\$370.7 (2.5%)	(63) (2.7%) behind schedule

Source: FAA.

Appendix IV: Baseline History for Programs Selected for Acquisition Performance Measurement

(Dollars in millions)

Program	Original schedule and budget			First rebaseline			Second rebaseline		
	Start date	Completion date	Budget	New APB ^a date	Revised completion date	Revised budget	New APB ^a date	Revised completion date	Revised budget
Standard Terminal Automation Replacement System	Feb-96	Oct-05	\$940.2	Oct-99	Sep-08	\$1,402.6	May-04	Dec-07	\$2,769.5
Next Generation Air-to-Ground Communication System	Sep-98	Sep-08	407.6	May-00	Sep-10	318.4	Dec-05	Sep-13	324.7
Operational and Supportability Implementation System	Dec-96	Aug-01	174.7	Mar-00	May-05	249.5	Feb-05	Jul-04	169.0
Integrated Terminal Weather System	Jun-97	Jul-03	276.1	Aug-01	Oct-03	282.3	Jun-04	Apr-09	286.1
Wide Area Augmentation System	Jan-98	Aug-99	1,006.6	Dec-99	Dec-06	2,978.0	May-04	Dec-08	3,339.7
FAA Telecommunications Infrastructure	Jul-99	Dec-08	205.7	Dec-04	Dec-07	310.2	Aug-06	Dec-08	318.8
Aviation Surface Weather Observation Network	Oct-99	Apr-02	350.9	Aug-01	Sep-09	403.8	Jun-06	Sep-12	384.3
National Airspace System Infrastructure Management System-Phase 2	May-00	Sep-05	172.9	Mar-06	Sep-06	90.2	Mar-07	Nov-07	90.2
Air Traffic Control Beacon Interrogator Replacement	Aug-97	Sep-04	282.9	Jan-02	Jan-06	282.9	May-08	May-10	255.1
Weather and Radar Processor	Dec-96	Feb-00	126.4	Oct-99	Feb-01	143.6			
Radio Control Equipment	Oct-98	Dec-01	260.4	N/A	Sep-03	260.4			
Airport Surveillance Radar - Model 11	Nov-97	Sep-05	743.3	Sep-05	Sep-09	696.5			
Local Area Augmentation System	Jan-98	Dec-06	536.1	Dec-99	Oct-11	696.0			
HOST/Oceanic Computer System Replacement	Mar-98	Sep-08	424.1	May-03	Jun-04	368.5			
Airport Movement Area Safety System	Oct-98	Aug-00	74.1	Mar-00	Sep-02	151.7			
Low-Level Wind Shear Alert System	Oct-98	Oct-01	43.5	May-01	Jun-04	52.6			
Airport Surface Detection Equipment - Model X (ASDE-X)	Sep-01	Jan-07	505.2 ^b	Sep-05	May-11	550.1			
Ultra High Frequency Replacement	Nov-02	Sep-10	85.1	Dec-05	Sep-13	85.1			

**Appendix IV: Baseline History for Programs
Selected for Acquisition Performance
Measurement**

Program	Original schedule and budget			First rebaseline			Second rebaseline		
	Start date	Completion date	Budget	New APB ^a date	Revised completion date	Revised budget	New APB ^a date	Revised completion date	Revised budget
Controller-Pilot Data Link Communications	Mar-99	Dec-05	166.7						
Backup Emergency Communications	Mar-00	Apr-04	54.1						
Advanced Technologies and Oceanic Procedures	May-01	Mar-06	548.2						
Precision Runway Monitor	Dec-01	Dec-05	145.8						
En Route Communication Gateway	Mar-02	Dec-05	315.1						
User Request Evaluation Tool	Jun-02	Sep-06	285.3						
Traffic Management Advisor	Jun-02	Sep-07	135.5						
En Route Automation Modernization	Jun-03	Dec-10	2,154.6						
En Route System Modernization	Aug-03	May-09	201.9						
Traffic Flow Management-Infrastructure	Aug-05	Apr-10	398.1						
Voice Recorder Replacement Program Next Generation	Apr-07	May-13	48.1						
Weather Systems Processor Tech Refresh	Mar-06	Feb-09	6.1						
Voice Switching and Control System Tech Refresh Phase 2	Aug-06	Jun-12	83.8						

Source: GAO analysis of FAA data.

Note: The Integrated Terminal Weather System program was rebaselined in 2007 with a new APB date of November 2007, a new program completion date of April 2009, and a budget of \$286.1 million.

^aAPB: acquisition program baseline.

^bIncludes \$80.9 million for the ASDE-3X baseline approved in June 2002, which added ASDE-X capabilities to seven ASDE-3 sites. The ASDE-X and ASDE-3X acquisitions were combined in the September 2005 rebaselining.

Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

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Acknowledgments

In addition to the contact named above, individuals making key contributions to this report include Teresa Spisak (Assistant Director), Kevin Egan, Elizabeth Eisenstadt, Brandon Haller, Bert Japikse, Edmond Menoche, Faye Morrison, Colleen Phillips, Taylor Reeves, and Richard Scott.

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