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NATIONAL AIRSPACE SYSTEM

Progress and Ongoing Challenges for the Air Traffic Organization

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GAO-05-485T

April 14, 2005

NATIONAL AIRSPACE SYSTEM

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Highlights

Highlights of GAO-05-485T, a testimony before the Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives

Why GAO Did This Study

Congress's formation of the Air Traffic Organization (ATO) and the Joint Planning and Development Office (JPDO), both within the Federal Aviation Administration (FAA), represent the latest efforts to address the monumental challenges of modernizing the national airspace system (NAS) during the first quarter of the twenty-first century. For more than two decades, FAA has been working to modernize the air traffic control (ATC) system, but projects have repeatedly missed cost, schedule, and performance targets. Consequently, ATC modernization has been on GAO's list of high-risk federal programs since 1995.

The ATO's focus is on a rolling 10-year outlook to operate and modernize the NAS. By contrast, the JPDO's vision is longer term, focused on coordinating the research efforts of diverse federal agencies to achieve a common goal of meeting potential air traffic demands in 2025.

This statement discusses (1) GAO's assessment of the ATO's efforts to date in addressing some of the key challenges for the ATC modernization program and (2) challenges that lie ahead for the ATO and options that it could consider in addressing the needs of the NAS over the next decade, as well as longer-term needs defined by the JPDO.

www.gao.gov/cgi-bin/getrpt?GAO-05-485T.

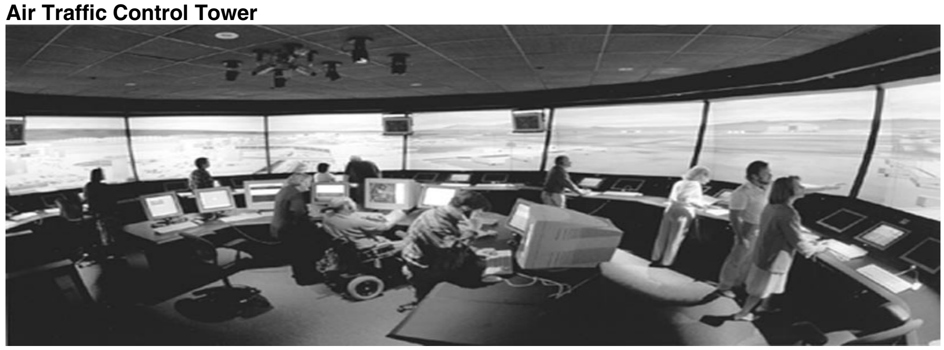
To view the full product, including the scope and methodology, click on the link above. For more information, contact Gerald L. Dillingham, (202) 512-2834, dillinghamg@gao.gov.

What GAO Found

The ATO is taking a number of positive steps to address the legacy cost, schedule, and performance problems that have affected the ATC modernization program for the past two decades. For example, the ATO is beginning to involve stakeholders early and throughout a system's development; has demonstrated a willingness to cut major acquisitions that are not meeting their goals, even after investing significant resources; and has improved its management of information technology. However, the ATO does not use a knowledge-based approach to acquisitions, characteristic of best commercial and federal practices, which would help avoid cost, schedule, and performance problems. Additionally, the ATO has used a process improvement model in several software-intensive acquisitions. However, because the ATO has not mandated use of the model in all such acquisitions, it risks taking a major step backwards in its capabilities for ATC systems and software. Finally, the ATO is taking steps to change the culture of its component organizations by, for example, replacing a personality-driven culture with one that is more sustainable and stable. Continued management attention in this area will be important to the organization's success.

The ATO faces the challenges of (1) modernizing and expanding NAS capacity to accommodate an expected 25-percent increase in the volume of air traffic over the next 10 years, (2) hiring thousands of air traffic controllers to replace those expected to retire over the next decade, (3) working with the new JPDO to coordinate the research efforts of diverse federal agencies to transform the NAS to meet potential air travel needs of 2025, and (4) addressing aging infrastructure. To fund its major system acquisitions through fiscal year 2009 while remaining within projected budget targets, the ATO has substantially reduced funding for other areas. However, the ATO does not provide administration and congressional decisionmakers with information about the impact of the reduced funding on NAS modernization. To deal with these challenges, some aviation experts suggested options that the ATO could consider, including contracting out more services and incurring debt to obtain multiyear funding for capital investments (an option requiring legislative change). Our work and some experts also suggest clarifying budget submissions to show decisionmakers how constrained budgets affect NAS modernization and how the ATO is working to live within its means.

Air Traffic Control Tower



Source: National Aeronautics and Space Administration.

Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to participate in today's hearing to discuss the implementation of the Federal Aviation Administration's (FAA) Air Traffic Organization (ATO) and the new Joint Planning and Development Office (JPDO). Both organizations represent the latest efforts of Congress and FAA to address the monumental challenges of transforming the national airspace system (NAS) during the first quarter of the twenty-first century. As key organizations for determining how to safely accommodate projected increases in air traffic demand, the ATO and JPDO are distinct yet complementary. The ATO's focus is on a rolling 10-year outlook to operate and modernize the NAS. By contrast, the JPDO's focus is longer term—determining how the NAS will meet possible air traffic demands in 2025.

As brief background: in 1981, over two decades ago, FAA began what it initially proposed as a 10-year program to replace and upgrade the NAS's facilities and equipment. However, systemic management problems associated with ATC system acquisitions and organizational culture resulted in cost growth, schedule slippages, and performance shortfalls, leading us to classify FAA's ATC modernization program as high risk in 1995.[1] In 2000, the administration issued an executive order that called for a performance-based air traffic organization to, among other things, improve the provision of air traffic services and accelerate modernization efforts, and Congress passed legislation that established an oversight body and a chief operating officer. FAA hired a chief operating officer in 2003 and in February 2004, formed the ATO, merging its former acquisitions[2] and air traffic operations offices, to manage FAA's air traffic control investments and operations. Congress also directed the Secretary of Transportation to establish the JPDO to develop a "next generation" transportation plan to meet air traffic demands by 2025. Located within FAA and reporting to the FAA Administrator, the JPDO has responsibility for coordinating the research efforts of several diverse federal agencies to support the goals of the next-generation plan.

My statement today will focus on two key questions: First, what is GAO's assessment of the ATO's efforts to date in addressing some of the key

[1]ATC modernization has remained on our high-risk list since 1995. See GAO *High Risk Series: An Update*, GAO-05-207 (Washington, D.C.: January 2005).

[2]These included FAA's Office of Research and Acquisitions and Free Flight Program Office.

challenges for the ATC modernization program? Second, what challenges lie ahead for the ATO, and what options could it consider in addressing the needs of the NAS over the next decade, as well as the longer-term needs defined by the JPDO? My statement is based on recently completed and ongoing studies for this committee and for the House Committee on Government Reform. We obtained information from FAA officials, an international panel of aviation experts, and relevant stakeholders on the ATO's prospects for addressing the systemic management problems on which we and others have reported. (See the list of related products at the end of this statement). Later this year, we expect to issue a detailed report that will address these and other related issues. We also obtained information and perspectives from the JPDO and other knowledgeable sources on its mission and plans for achieving that mission. We performed our work in accordance with generally accepted government auditing standards.

In summary:

- The ATO is taking a number of positive steps to address legacy challenges in system acquisitions and organizational culture that have affected the ATC modernization program for the past two decades. Our work indicates that four interrelated factors have contributed to the legacy challenges in meeting system acquisitions' cost, schedule, and performance targets: (1) funding acquisitions at lower levels than called for in agency planning documents, (2) adding requirements and/or unplanned work, (3) underestimating the complexity of software development, and (4) not sufficiently involving stakeholders throughout system development. Among the positive steps it is taking, the ATO is beginning to include stakeholders in all phases of system development, so that they can provide input in response to technical or financial developments. The ATO has also demonstrated a willingness to cut some major acquisitions that are not meeting their goals, even after investment of significant resources. And it has improved its management of information technology investments and software-intensive acquisitions. However, the ATO does not use a knowledge-based approach to system acquisitions, characteristic of best commercial practices for managing commercial and Department of Defense (DOD) product developments, which would help avoid cost, schedule, and performance problems. Additionally, because the ATO has not mandated use of a process improvement model for all software-intensive acquisitions, it risks taking a major step backwards in its capabilities for ATC systems and software. Finally, the ATO has recognized the fundamental importance of changing its organizational culture; it has been working on altering its leadership model and replacing a personality-driven culture—one that changes as leadership changes—

with one that is sustainable and stable. Continued improvement and management attention will be crucial if the organization's efforts are to succeed.

- The ATO's key challenges include modernizing and increasing NAS capacity to accommodate a 25-percent increase in air traffic operations by 2015, hiring thousands of air traffic controllers to replace those expected to retire in the next decade, working with the new JPDO to ensure that research programs led by diverse agencies support national goals, and repairing or replacing facilities believed to be beyond their useful lives. The ATO will be further challenged to accomplish these tasks while remaining within the administration's future budget targets, which are lower than those of recent years. To fund its major system acquisitions while remaining within the budget targets, the ATO has eliminated planned funding to start new projects and substantially reduced planned funding for other areas. However, when forwarding its budget submission for administration and congressional review, the ATO provides no detail on the impact of the planned funding reductions on ATC or NAS modernization. Aviation experts and our work have identified options for the ATO to increase its chances of success. First, some aviation experts proposed that the ATO evaluate its experience in contracting out flight service stations and, if positive, consider contracting out other services. Second, some experts suggested that the ATO be allowed to incur debt so that it could obtain multiyear funding for capital investments, an option that would require a legislative change. While we have consistently maintained that Congress should control new funding sources through the budget and appropriations processes, these experts believed that giving the ATO access to multiyear funds for capital investments would increase its flexibility, thereby allowing it to modernize systems more efficiently. Third, our preliminary work shows, and some experts agreed, that the ATO should provide the administration and Congress with detailed information in its budget submissions about the impact of reduced budgets on both ATC and NAS modernization. To do so, the ATO should explicitly identify the trade-offs it is making to reach administration budget targets, highlighting those programs slated for increased funding and those slated for reduced funding.

The ATO Has Made Progress in Addressing Key Challenges and Needs to Continue

The ATO inherited a decades-long legacy of cost, schedule, and performance problems in the ATC modernization program. We found that four interrelated factors contributed to these problems. The ATO has taken a number of positive steps to address these issues through improvements in its management of information technology investments and software-intensive acquisitions, but there is room for further progress. Additionally, the ATO recognizes that changing its organizational culture is a key challenge underlying its transition to a highly effective, performance-based organization. Options are available to help the ATO address these challenges.

Four Interrelated Factors Contributed to Acquisitions Missing Cost, Schedule, and Performance Targets

Our research shows that four common factors emerged that contributed to 12 of FAA's 16 major systems missing their original cost, schedule, or performance targets. (See table 1.) Appendix I provides the full name and a description of each of the 16 systems. Appendix II shows changes in cost and schedule for these systems.

Table 1: Four Key Factors Contributing to Cost Growth, Schedule Extensions, and Performance Shortfalls for 12 ATC System Acquisitions

Name of system	The funding level received was less than the agency-approved funding level[a]	The system acquisition experienced requirements growth and/or unplanned work	The complexity of software development was underestimated	Stakeholders were not sufficiently involved
ASDE-X	X			
ASR-11	X	X		
ATCBI-6	X			
CPDLC		X		
FFP2	X			
ITWS	X	X	X	
LAAS		X	X	X
NEXCOM	X	X		
NIMS-2	X	X		
OASIS	X	X	X	X
STARS		X		X
WAAS		X	X	X

Source: GAO Analysis of FAA Data

[a] Agency approved funding level refers to the annual funding required to deliver a system as planned—that is, as documented in an acquisition program baseline, the document approved by the agency at the beginning of an acquisition. In December 2004, the ATO began using the Office of Management and Budget's Capital Asset Plan and Business Case (exhibit 300) in place of the acquisition program baseline, as the primary decisionmaking document for acquisitions.

Note: Blank spaces in the chart denote that the specific factor was not a key contributor to a program's inability to meet cost, schedule, or performance targets. The remaining four major systems we reviewed are FTI, ERAM, ECG, and ATOP. FTI's revised baseline reflected increased costs to cover requirements which, while included in the original baseline, were unknown at the time the original baseline was prepared. ERAM, ECG, and ATOP are generally meeting cost, schedule, and performance targets.

According to FAA officials, funding gaps contributed to problems in one or more of three areas—cost, schedule, and performance—for 8 of the 12 system acquisitions. Most major acquisition programs establish a baseline that describes the programs' estimated annual costs, planned schedules, and performance expectations, which is approved by FAA's Joint Resources Council—the agency's executive body responsible for approving and overseeing major system acquisitions.[3] The estimated cost for a given year assumes that the program received all funding for prior fiscal years as described in the baseline. In practice, however, this is not always the case. For example, when FAA's budget level does not allow all system acquisitions to be fully funded at the levels approved in their baselines, FAA may elect to fully fund higher-priority acquisitions and provide less funding for lower-priority acquisitions than called for in their baselines. The ASR-11 acquisition, a digital radar system, illustrates how reduced funding has resulted in cost growth and schedule delays. FAA officials stated that because of funding reductions and reprogramming, the program received $46.45 million less than requested for fiscal years 2004 and 2005. According to FAA officials, total costs may escalate and schedules may slip under such circumstances.

The stories behind cost and schedule increases for WAAS—a satellite navigation system—and STARS—new controller and maintenance workstations—demonstrate how the remaining three contributing factors can interact. For WAAS, FAA underestimated the complexity of the software that would be needed to support this system when it reduced, by 3 years, its plans to develop, test, and commission the system. FAA then

[3] The Joint Resources Council is an executive body consisting of associate and assistant administrators, acquisition executives, the chief financial officer, the chief information officer, and legal counsel. The council determines, among other things, whether an acquisition meets a mission need and should proceed. The council also approves changes to a program's baseline, budget submissions, and the NAS architecture baseline.

tried to accomplish these tasks in 28 months, even though the software development alone was originally expected to take from 24 to 28 months. In retrospect, FAA acknowledged that the agency's in-house technical expertise was not sufficient to address WAAS's technical challenges, particularly the need to warn pilots in a timely manner when a system may be giving them potentially misleading and therefore hazardous information. FAA's efforts to resolve this issue resulted in unplanned work, which contributed to a $1.5 billion increase over the 1994 baseline costs and to a 6-year delay in commissioning the system. According to FAA, adding the cost of satellite leases, formerly listed as an operating cost, to the capital cost and adding 6 years to the program's life cycle also contributed to increased costs.

For STARS, a joint FAA/DOD acquisition, not adequately including stakeholders in development led to unplanned work, cost growth, schedule delays, and reduced deployment. Because the program's aggressive development schedule allowed for only limited evaluation by controllers and maintenance technicians, FAA and the contractor failed to recognize human-factors concerns that these stakeholders later identified.[4] Restructuring the contract to make up for these oversights contributed to $500 million in cost growth, a 7-year schedule delay, and a reduction in deployment from 172 to 47 facilities.

Three of the major ATC system acquisitions are currently operating within their original cost, schedule, and performance targets, but have exhibited symptoms of past problems, such as requirements growth or underestimating the complexity of software requirements. These acquisitions include a system for processing flight data for oceanic flights (ATOP), a communications system (gateway) for controlling high-altitude traffic at 20 en route facilities (ECG), and a replacement for the primary computer system used for controlling air traffic (ERAM). Despite successes to date, these acquisition programs will require sustained management attention to help ensure that they remain within their cost, schedule, and performance targets.

[4] A human-factors evaluation examines how humans interact with machines and identifies ways to enhance operators' performance and minimize errors.

ATO Is Taking Some Positive Steps to Address Legacy Acquisition Problems

The ATO has already taken some steps to control the legacy problems identified with the ATC modernization program.[5] For example, it has begun to include stakeholders throughout system development, so that they can provide input in response to technical or financial developments. Reviews of a precision-landing system augmented by satellites (LAAS), a digital e-mail-type communication system between controllers and pilots (CPDLC), and the next generation air/ground communication system (NEXCOM)—each of which had cost, schedule, and performance problems to varying degrees—contributed to the ATO's reducing or eliminating funding for these systems in FAA's budget request for fiscal year 2005. Additionally, the ATO has established collaborative teams of technical experts and ATC system users, reorganized air traffic services and the research and acquisition organization along functional lines of business to bring stakeholders together and integrate goals, rewarded cooperation by linking investments to operations, started preparing agency planning documents in a format consistent with that prescribed by the Office of Management and Budget, begun implementing portions of a cost accounting system, and reduced layers of management from 11 to 7 to help address the hierarchical nature of the organization.

These are positive steps. We believe the ATO should continue the phased approach to acquiring new systems, and involving stakeholders throughout a system's development should help avoid the types of problems that led to cost growth and delays for STARS. Additionally, we view the decision to cut major systems as an indication that the ATO is willing to make difficult decisions to suspend major ATC system acquisitions that are not achieving their intended goals—even after a substantial investment of agency resources.

FAA has made progress in addressing long-standing problems with managing the risks associated with acquiring major ATC systems, many of which are software-intensive, but further improvement is possible. For example, FAA has established some discipline for acquiring these systems through the Acquisition Management System that it began implementing after Congress exempted the agency from federal acquisition regulations in 1995. Also, FAA has begun basing funding decisions for system acquisitions, in part, on their contribution to reducing the agency's operating costs while maintaining safety. Currently, FTI, a new

[5]The improvements spanned the period when FAA created the ATO. In the future, the ATO will have the primary responsibility for making further improvements in these areas.

telecommunications system, is the only acquisition that will reduce FAA's operating costs. Most of FAA's major system acquisitions are aimed at increasing NAS capacity and delivering benefits to users.

However, as we reported last fall, the Acquisition Management System still does not ensure that FAA uses a knowledge-based approach to acquisition that is characteristic of the best procurement practices used in commercial entities or by DOD. Capturing specific knowledge and using it to determine whether a product has reached a level of development (product maturity) sufficient to demonstrate its readiness to move forward in the acquisition process helps to avoid cost overruns, schedule slips, and performance shortfalls that can occur if decision-makers commit to a system design before acquiring critical technology, design, or manufacturing knowledge.

FAA has reported that it met its annual acquisition performance goal for fiscal year 2004—to meet 80 percent of designated milestones and maintain 80 percent of critical program costs within 10 percent of the budget, as published in its Capital Investment Plan. In our opinion, having and meeting such performance goals is commendable, but it is important to note that these goals are updated program milestones and cost targets, not those set at the program's inception.[6] Consequently, they do not provide a consistent benchmark for assessing progress over time. Moreover, as indicators of annual progress, they cannot be used in isolation to measure progress in meeting cost and schedule goals over the life of an acquisition. Finally, given the problems FAA has had in acquiring major ATC systems for over two decades, it is too soon to tell whether meeting these annual performance goals will ultimately improve the agency's ability to deliver system acquisitions as promised.

[6]Our statements about cost, schedule, and performance in this testimony and in our past reports are based on original targets that FAA established and approved at the start of its acquisition programs.

FAA has made considerable progress in managing its information technology investments.[7] FAA recently informed us that it has taken a number of steps aimed at achieving a higher maturity level, including establishing service-level mission need statements and service-level reviews, which address operational systems to ensure they are achieving the expected level of performance. While these steps could resolve some of the deficiencies that we previously reported, we have not yet performed our own evaluation of these steps. FAA could realize considerable savings if these reviews result in the discontinuation of some investments, since operating systems beyond their second year of service accounted for 37 percent of FAA's total investment in information technology in fiscal year 2004.

Finally, FAA has made progress in improving its process for acquiring software-intensive systems. The quality of these systems and software, which are essential to FAA's ATC modernization program, depends on the value and maturity of the process used to acquire, develop, manage, and maintain them. In response to our previous recommendations, FAA developed an FAA-integrated capability maturity model (iCMM).[8] Since FAA implemented the model, a growing number of system acquisitions have adopted the model, and its use has paid off in enhanced productivity, higher quality, greater ability to predict schedules and resources, better morale, and improved communication and teamwork. However, while FAA has encouraged process improvement through iCMM, use of the model has remained voluntary, and the agency's future commitment to this

[7]GAO, *Information Technology*: *FAA has Many Investment Management Capabilities in Place, but More Oversight of Operational Systems Is Needed*, GAO-04-822 (Washington, D.C.: Aug. 20, 2004). This report evaluates how FAA's information technology investment management for NAS systems and other systems compares to our Information Technology Investment Management Framework. Information technology systems used in air traffic control are the principal technology component of the NAS. The framework is a maturity model composed of five progressive stages, based on our research and the practices of leading private- and public-sector organizations. For more information on the Information Technology Investment Management Framework, see GAO, *Information Technology Investment Management: A Framework for Assessing and Improving Process Maturity*, GAO-04-394G (Washington, D.C.: Mar. 1, 2004).

[8]GAO, *Air Traffic Control: System Management Capabilities Improved, but More Can be Done to Institutionalize Improvements*, GAO-04-901, (Washington, D.C.: Aug. 20, 2004). iCMM is similar to the Capability Maturity Model® (CMM) Integration (CMMI℠) developed by Carnegie Mellon University's Software Engineering Institute, but crafted to include international standards. CMM®, Capability Maturity Model, and Capability Maturity Modeling are registered in the U.S. Patent and Trademark Office. CMMI℠ is a service mark of Carnegie Mellon University. For a detailed description of these models, see GAO-04-901.

initiative is not certain. Unless FAA demonstrates a strong commitment to process improvement and establishes a consistent, institutional approach to implementing and evaluating this process improvement, the agency risks taking a major step backwards in its capabilities for ATC systems and software.

FAA has also continued to develop an enterprise architecture—a blueprint of the agency's current and target operations and infrastructure. However, this architecture is still not complete and compliance is not yet enforced. We have ongoing work evaluating what the agency needs to do to develop and enforce its enterprise architecture.

ATO Recognizes the Importance of Organizational Culture for Facilitating Transition

Recognizing that cultural factors can play a critical role in an organization's success, the ATO has initiated organizational changes that are designed to create a foundation for cultural change in the acquisitions and operations workforces, which FAA combined to form the new organization. For example, the ATO is giving high priority to changing its leadership model by linking top management more closely to operations in the field and by replacing "command and control" with communication across organizational levels. In the past, according to the chief operating officer, FAA's management culture was "intensely hierarchical, risk averse," and "reactionary." But now, he said, FAA is attempting to foster "results-focused, proactive and innovative behavior." Changing the agency's leadership model is also designed, he said, to replace a "personality-driven culture" with a viable, stable, and sustainable organization that can make rational decisions that transcend changes in leadership.

To further support cultural change, the ATO is emphasizing accountability and other core values. For example, it is holding managers accountable for managing their budgets and in fiscal year 2006, it plans to include financial management among the pay-for-performance criteria for its managers. Additionally, the ATO is using the results of the most recent Employee Attitude Survey[9] to set a baseline for cultural improvement in five core areas—(1) integrity and honesty, (2) accountability and responsibility, (3) commitment to excellence, (4) commitment to people, and (5) fiscal responsibility. FAA's Civil Aerospace Medical Institute analyzed the survey

[9]The most recent survey was administered in September 2003, before the ATO was formed. FAA organized the responses by suborganization to be consistent with the new ATO.

results by grouping three to seven survey items under each of these areas. For example, FAA placed the survey item "We are encouraged to express our concerns openly" with four other items under the Integrity and Honesty core value. For many items, across all core values, fewer than 40 percent of ATO employees indicated agreement or strong agreement. We are comparing the results of FAA's Employee Attitude Survey with our 1996 findings identifying culture as a problem in the acquisition workforce, which is now within the ATO.[10] We plan to report our findings later this year.

It is incumbent upon the ATO, as it moves forward, to follow through with its commitment to transform the culture of its component organizations. Our studies suggest that transformations need focused, full-time attention from a dedicated team. The team must have vested authority and resources from top management to set priorities, make timely decisions, and move quickly to implement decisions. Such a team provides a visible signal that the transition is being undertaken with the utmost seriousness and commitment. Having a dedicated transition team is just one of several practices that we have identified, such as setting implementation goals and a timeline and establishing a communication strategy, that are key to successful mergers and organizational transformations. (See app. III for a complete list.)

To Address the Challenges of Modernizing and Expanding the NAS While Living within Its Means, the ATO Has a Number of Options

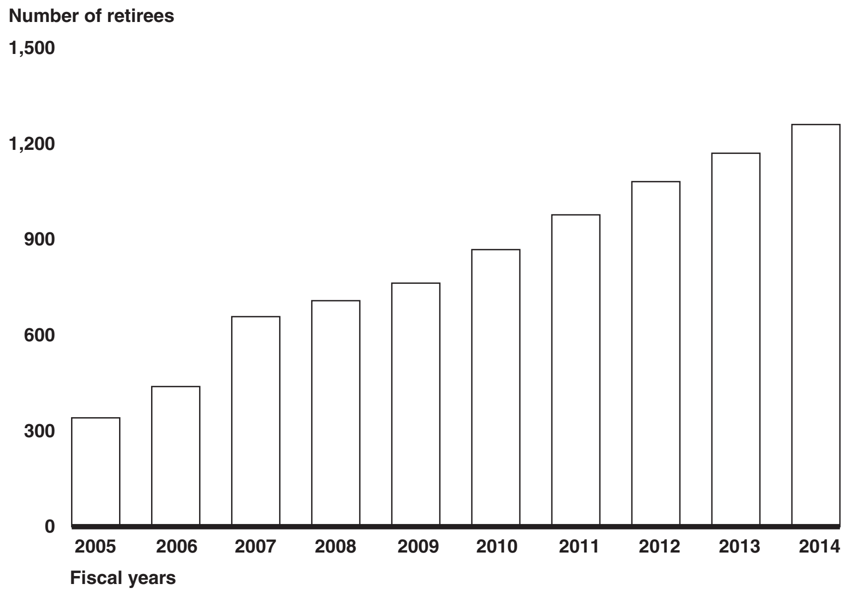
The ATO faces multiple challenges: (1) expanding and modernizing the NAS to accommodate an expected 25-percent increase in the volume of air traffic over the next 10 years; (2) hiring thousands of air traffic controllers to replace those expected to retire over the next decade; (3) working with the new JPDO to coordinate the research efforts of diverse federal agencies to transform the NAS to meet potential air travel needs of 2025; and (4) addressing aging infrastructure. The ATO faces the additional challenge of accomplishing these tasks with less funding than it has received in the past. A number of options are available for the ATO to consider in addressing these challenges.

The ATO plans to continue modernizing and expanding the capacity of the NAS to accommodate an expected 25-percent increase in air traffic volume over the next 10 years. Even after cuts to the LAAS, CPDLC, and NEXCOM

[10] GAO, *Aviation Acquisition: A Comprehensive Strategy Is Needed for Cultural Change at FAA*, GAO/RCED-96-159 (Washington, D.C.: Aug. 22, 1996).

budgets, the remaining major ATC systems would consume $4.4 billion, or 45 percent of FAA's total planned funding (excluding personnel and travel) for fiscal years 2005 through 2009. The funding situation is further exacerbated by the ATO's need to hire and train thousands of air traffic controllers to replace those reaching retirement eligibility over the next decade. (See fig. 1.)

Figure 1: Projected Controller Retirements, Fiscal Years 2005-2014



Source: FAA.

Additionally, as the ATO works with the JPDO to address the NAS's potential needs 20 years into the future, it will need to ensure linkage to and continuity with its own 10-year plans. The JPDO is responsible for developing a national vision and plan that will prepare the NAS to meet an assumed tripling of air traffic demand by 2025. In its first report, in December 2004, the JPDO concluded that meeting this demand would require a complete transformation of the NAS. It also predicted that fossil fuels would become less available and more costly, and global travel and commerce would become more interdependent. As one senior JPDO official suggested, if we fail to consider these issues now, future passengers may not be able to fly to their destinations in a single day and overnight package delivery may become a thing of the past. While the JPDO's plan did not discuss costs, the Vision 100—Century of Aviation

Reauthorization Act authorized $50 million annually for fiscal years 2004 through 2010 for the JPDO.

The ATO will be challenged to harness the efforts of the diverse agencies that participate in the JDPO, including DOD, the Department of Homeland Security and the National Aeronautics and Space Administration, and to align these efforts with the goals of the national plan. Although a relatively new organization, the JPDO has defined eight interdependent strategies to guide its work towards transforming the NAS and has established integrated product teams, each led by a participating federal agency, to address each of these strategies. These agencies have historically "gone their own way," with little thought given to coordinating with other agencies and moving toward a common goal. Aviation experts told us that within FAA, there is resistance to having outside organizations, rather than FAA, develop new procedures and systems for FAA to approve and institute. This will have to change under the JPDO paradigm.

Additionally, the ATO has cited the need to renew its aging infrastructure. The ATO estimates that such renewal will require an annual investment of $2.5 billion, assuming a $30-billion value of its assets and 7- to 12-year useful lives. According to the ATO, much of its physical infrastructure, including the buildings and towers that house costly ATC systems, is over 30 years old on average.[11] (See table 2.)

Table 2: Age of NAS Facilities

Facility	Average age
En route traffic control facilities	40 years
Air traffic control towers	30 years
Terminal approach control centers	34 years

Source: FAA.

Continued Reductions in Funding Levels Will Challenge the ATO's Ability to Live within Its Means

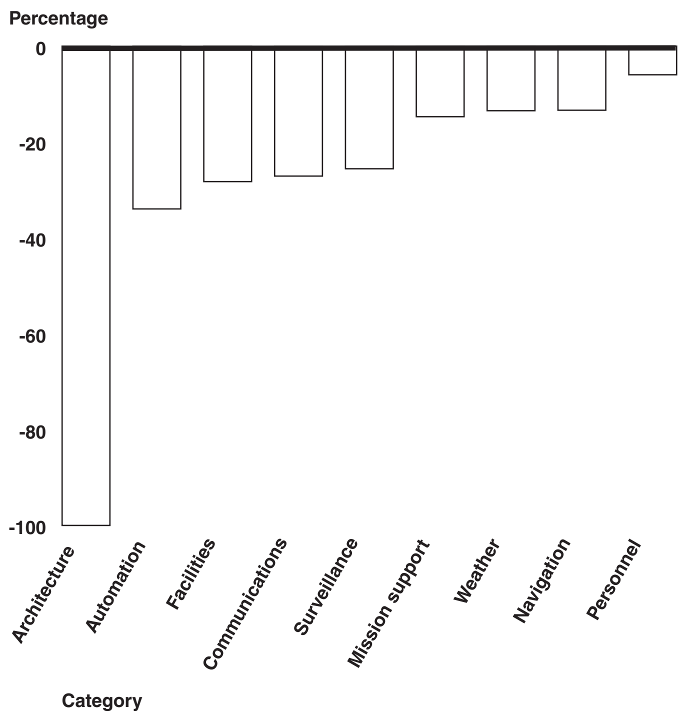
Because Office of Management and Budget funding targets for fiscal years 2005 through 2009 are lower than those for recent fiscal years, the chief operating officer predicts a cumulative $5-billion gap in operations funding and a $3.2-billion gap in capital funding. He said that, in effect, remaining within these lower targets would require a 21-percent reduction in costs and a 9-percent increase in productivity. The chief operating officer also

[11]We have not verified the ATO's reported refurbishment and replacement needs.

predicts that currently planned cost-saving measures would produce only half of the needed savings. One aviation expert predicted that the gaps would more likely have a gradual effect, rather than an immediately catastrophic effect, manifested by a slow but sure increase in air traffic delays.

To provide the $4.4 billion needed for its major system acquisitions while remaining within its budget targets through fiscal year 2009, the ATO has made significant cuts elsewhere in its capital funding plans. For example, the ATO eliminated all of the $1.4 billion that it had set aside for what it calls the "architecture segment." (See fig. 2.) These funds would have been used to perform about 2 years' worth of early research on new programs before they are mature enough to receive formal Joint Resources Council approval. The ATO also made significant reductions in planned investments for facilities—an action that runs counter to its reported need to refurbish or replace its physical infrastructure.

Figure 2: Capital Investment Plan Reductions, by Category, January 2005 Compared with January 2003



Source: GAO presentation of FAA data.

Such reductions reflect the end result of difficult decisions about which programs to fund and which to cut in order to remain within the administration's budget targets. However, when forwarding its budget submission for administration and congressional review, the ATO does not highlight the programs slated for increased or reduced funding and does not identify the impact of these decisions on ATC and NAS modernization. Such information would make clear how constrained budgets will affect NAS modernization and how the ATO is working to live within its means.

The ATO Has Options to Increase Its Prospects for Success

Contracting out more services and proposing legislation to provide borrowing authority are two options proposed by aviation experts[12] to improve the ATO's chances of success. A third option, providing more clarity in budget submissions, is supported by our work and some experts.

First, some members of our expert panel suggested that the analysis performed on contracting out flight service stations could be extended to other functions, such as oceanic or en route air traffic control, or nighttime operations. Under this option, experts said that ongoing government oversight could ensure the safety of contracted operations, and such a "staged outsourcing" of the NAS's functions might build confidence in the private sector's ability to provide air traffic services safely and efficiently. We view the agency's decision to study the contracting out of flight services as a significant step towards cost reduction and one that could be selectively expanded to other services if the current experience proves positive.

Second, some experts suggested that the ATO finance its capital investments by incurring debt through private capital markets, rather than relying on annual appropriations. While we have consistently maintained that Congress should control new funding sources through the budget and appropriations processes, these experts believed that debt financing would increase the ATO's flexibility by providing a dedicated, multiyear source of funds that it could manage as program needs dictate, thereby allowing it to modernize more efficiently. A legislative change would be required to give the ATO borrowing authority.

Our preliminary work shows, and some aviation experts maintain, that the ATO needs to prioritize its capital investments, as well as its investments in operating systems, with affordability in mind. These experts believe that the ATO needs to review all of its spending plans for modernization, determine which programs can realistically be funded, and select programs to cut. They also indicated that the ATO should have a mechanism to explain to Congress the implications that cutting the funding for one system has on other systems. Indeed, the ATO appears to

[12] As part of our research, we sought the perspective of an international group of experts. One of the issues that we asked these experts to address was how the ATO can improve its chances of achieving its mission. The options presented were identified by one or more members of our expert panel and do not necessarily reflect the views of GAO or of the panel as a whole. We expect to present additional options in our forthcoming report on the status of NAS modernization.

be prioritizing its investments, as indicated by the varying percentage reductions in various planned capital investments. We believe that the ATO could clarify how these trade-offs affect progress in modernizing the ATC system and related components of the NAS in the near, mid-, and longer term. Such transparency would provide senior agency officials and Congress with a clear view of how the ATO is working to live within its means.

In summary, we believe that the ATO has taken a number of positive steps. With continued management attention and focus to carry the momentum forward, the ATO has an opportunity to address its heretofore intractable problems with ATC modernization.

This concludes my statement. I would be pleased to respond to any questions that you or other Members of the Subcommittee may have at this time.

Contact and Acknowledgements

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Appendix I: Major ATC System Acquisitions

Air Traffic Control Radar Beacon Interrogator – Replacement (ATCBI-6)

ATCBI-6 is a replacement radar capable of determining both range and direction to and from the aircraft. It can also forward this information to the appropriate air route traffic control centers. It will replace radars that have exceeded their life expectancy and have proved extremely vulnerable to outages and critical-parts shortages.

Advanced Technologies and Oceanic Procedures (ATOP)

ATOP is an integrated system of new controller workstations, data-processing equipment, and software that will enhance the control and flow of oceanic air traffic to and from the United States. ATOP is planned for the three sites that control oceanic air traffic: Anchorage, Alaska; New York, New York; and Oakland, California.

Airport Surface Detection System – Model X (ASDE-X)

ASDE-X is an airport surveillance system that enables air traffic controllers to track the surface movement of aircraft and vehicles. The detection system automatically predicts potential conflicts and seamlessly covers airport runways, taxiways, and other areas.

Airport Surveillance Radar Model-11 (ASR-11)

ASR-11 is a digital radar that replaces aging analog radars, such as ASR-7 and ASR-8, with a single, integrated digital radar system. ASR-11 reduces operational costs, improves safety, and can accommodate future capacity increases.

Controller-Pilot Data Link Communications (CPDLC)

CPDLC is a communication system that will allow pilots and controllers to transmit digital data messages directly between FAA automated ground computers and aircraft.

En Route Automation Modernization (ERAM)

ERAM will replace software and hardware in the host computers at FAA's 20 en route air traffic control centers, which provide separation, routing, and advisory information. It provides a flexible and expandable base to facilitate further national airspace system (NAS) modernization initiatives.

En route Communications Gateway (ECG)

ECG provides a communications interface between radar sites and en route centers, and is a precursor to ERAM. The system has an open and expandable platform that allows for new connectivity and functionality as the NAS evolves. It replaces the interim Peripheral Adapter Module Replacement Item that has been operating for 10 years and has exceeded its life expectancy.

FAA Telecommunications Infrastructure (FTI)

FTI is FAA's new telecommunications system. It will replace costly networks of separately managed systems and services—both leased and owned—by integrating advanced telecommunications services within FAA's NAS and non-NAS infrastructures.

Free Flight Phase 2 (FFP2)

FFP2 is a suite of air traffic control tools and subsystems that allows air traffic controllers to move gradually from a highly structured system, based on elaborate rules and procedures, to a more flexible system wherein pilots, within limits, can change their route, speed, and altitude while keeping air traffic controllers informed of such changes. It includes the Traffic Management Advisor, Collaborative Decisionmaking, User Request Evaluation Tool, and the Surface Management Advisor.

Integrated Terminal Weather System (ITWS)

ITWS is a weather information system that furnishes air traffic controllers and supervisors with full-color graphic displays of weather conditions that need no meteorological interpretation. It provides a comprehensive representation of the current weather situation and precise 20 minute forecasts (to be increased to 60 minutes in 2006) of convective weather conditions.

Local Area Augmentation System (LAAS)

LAAS is a landing guidance system that would use global positioning satellites and would be installed at airports to allow aircraft to execute precision instrument approaches and landings in all weather conditions. LAAS would eliminate the need for multiple instrument landing systems at airports where it is installed.

NAS Infrastructure Management System—Phase 2 (NIMS-2)

NIMS is a centralized system to help manage and schedule maintenance on the NAS infrastructure, including its facilities, systems, and equipment. NIMS will decrease the number of en route delays by reducing the time required to restore systems to full operation following maintenance. NIMS Phase 1, already complete, provides initial Operational Control Center capability, along with remote monitoring and control functionality, to 3,700 NAS facilities and 5,800 deployed maintenance data terminals.[1] Phase 2 will fully implement resource management and enterprise management software and focus on increasing workers' productivity in receiving orders and managing resources.

Next Generation Air/Ground Communications (NEXCOM)

NEXCOM is a digital communications system, consisting of multimodal digital radios, avionics, and ground stations, which will improve air traffic control communications by replacing old analog communication systems. Segment 1A will replace 30- to 40-year-old radios, deploying 6,000 new radio sets that use analog and digital communications with aircraft. Segment 1B will create ground stations to communicate with aircraft equipped with digital capability.

Operational and Supportability Implementation System (OASIS)

OASIS a system used at flight service stations to assist general aviation pilots with flight planning. The system provides up-to-the-minute weather graphics by integrating real-time weather and flight planning data with overlays of flight routes. It replaces the Flight Services Automation system for which spare parts and hardware support have been difficult for FAA to obtain.

[1]Operational Control Center capability, established in 2001, was a standard set of tools and procedures needed to open the control centers. The tools provide the initial enterprise management and resource management technical capabilities needed at Operational Control Centers.

Standard Terminal Automation Replacement System (STARS)

STARS is workstation to allow civilian and military air traffic controllers to direct aircraft near major U.S. airports and will replace aging workstations at certain facilities. It has an open and expandable terminal automation platform that can accommodate air traffic growth, as well as new hardware and software that is designed to promote safety, maximize operational efficiency, and improve controllers' productivity.

Wide Area Augmentation System (WAAS)

WAAS is a navigation and landing guidance system that uses global positioning satellites to provide precise navigation and landing guidance at all airports, including thousands that have no ground-based instrument landing capability.

Appendix II: Changes in Cost and Schedule Targets for 16 Major ATC System Acquisitions

Dollars in millions

ATC system	Cost targets				Last site implementation targets		
	Original date	Original cost	Current cost (as of March 2005)	Change	Original date	Current date	Change (in years)
Airport Surface Detection Equipment – Model X (ASDE-X)	September 2001	$424.3	$510.2	$85.9[a]	2007	2009[b]	2
Airport Surveillance Radar Model – 11 (ASR-11)	November 1997	$743	$916	$173	2005	2013	8
Air Traffic Control Radar Beacon Interrogator – Replacement (ATCBI-6)	August 1997	$281.8	$282.9	$1.10	2004	2008	4
Advanced Technologies and Oceanic Procedures (ATOP)	June 2001	$548.2	$548.2	None	2006	2006	None
Controller-Pilot Data Link Communications (CPDLC)	1999	$166.7	To be determined	Not applicable	June 2005	To be determined	Not applicable
En Route Communications Gateway (ECG)	March 2002	$245.2	$245.2	None	2005	2005	None
En Route Automation Modernization (ERAM)	June 2003	$2,150	$2,150	None	December 2010	December 2010	None
Free Flight Phase 2 (FFP2)	June 2002	$546.2	$546.2	None	2006	2007	1
FAA Telecommunications Infrastructure (FTI)	July 1999	$205.7	$310.2	$104.5[c]	2008	2008	None
Integrated Terminal Weather System (ITWS)	June 1997	$276.1	$286.1	$10	July 2003	2009+	6+
Local Area Augmentation System (LAAS)	January 1998	$530.1	$696.1	$166	2006	To be determined	Not applicable
Next Generation Air/Ground Communications (NEXCOM)	September 1998	$405.7 (First segment only)	$986.4 (First segment only)	$580.7	2008	To be determined	Not applicable
NAS Infrastructure Management System – Phase 2 (NIMS – 2)	May 2000	$172.9	$172.9	None	2005	2010[d]	5
Operational and Supportability Implementation System (OASIS)	April 1997	$174.7	$155.50	($19.2)	2001	2004	3
Standard Terminal Automation Replacement System (STARS)	February 1996	$940	$1,460 (Phase 1 only)	$520	2005	2008	3
Wide Area Augmentation System (WAAS)	1994	$509	$2,036	$1,527[e]	December 2000	2013	13

Source: GAO presentation of FAA data.

[a]FAA plans to extend ASDE-X's current deployment target from 2007 to 2009 because the project's budgets were cut in fiscal years 2004 and 2005.

[b]According to FAA officials, the change in cost target for ASDE-X was due to an increase in the scope of the project.

[c]The increased costs were for requirements which, while included in the original baseline, were unknown at the time the original baseline was prepared.

[d]In light of reduced funding, FAA is revising NIMS-2's targets; a Joint Resources Council decision is planned for May 2005.

[e]According to FAA, adding the cost of satellite leases, formerly listed as an operating cost, to the capital cost and adding 6 years to the program's life cycle contributed to increased costs.

Appendix III: Key Practices and Implementation Steps for Mergers and Organizational Transformations

Practice	Implementation steps
Ensure top leadership drives the transformation.	Define and articulate a succinct and compelling reason for change. Balance continued delivery of services with merger and transformation activities.
Establish a coherent mission and integrated strategic goals to guide the transformation.	Adopt leading practices for results-oriented strategic planning and reporting.
Focus on a key set of principles and priorities at the outset of the transformation.	Embed core values in every aspect of the organization to reinforce the new culture.
Set implementation goals and a time line to build momentum and show progress from day one.	Make public implementation goals and time line. Seek and monitor employee attitudes and take appropriate follow-up actions. Identify cultural features of merging organizations to increase understanding of former work environments. Attract and retain key talent. Establish an organizationwide knowledge and skills inventory to allow knowledge exchange among merging organizations.
Dedicate an implementation team to manage the transformation process.	Establish networks to support the implementation team. Select high-performing team members.
Use the performance management system to define responsibility and ensure accountability for change.	Adopt leading practices to implement effective performance management systems with adequate safeguards.
Establish a communication strategy to create shared expectations and report related progress.	Communicate early and often to build trust. Ensure consistency of message. Encourage two-way communication. Provide information to meet specific needs of employees.
Involve employees to obtain their ideas and gain ownership for the transformation.	Use employee teams. Involve employees in planning and sharing performance information. Incorporate employee feedback into new policies and procedures. Delegate authority to appropriate organizational levels.
Build a world-class organization.	Adopt leading practices to build a world-class organization.

Source: GAO.

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