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NEXT GENERATION AIR TRANSPORTATION SYSTEM

Progress and Challenges
Associated with the
Transformation of the
National Airspace
System



Highlights of **GAO-07-25**, a report to congressional requesters

NEXT GENERATION AIR TRANSPORTATION SYSTEM

Progress and Challenges Associated with the Transformation of the National Airspace System

Why GAO Did This Study

In 2003, Congress created the Joint Planning and Development Office (JPDO) to plan for and coordinate, with federal and nonfederal stakeholders, a transformation from the current air traffic control system to the “next generation air transportation system” (NGATS) by 2025. Housed within the Federal Aviation Administration (FAA), JPDO has seven partner agencies: the Departments of Transportation, Commerce, Defense, and Homeland Security; FAA; the National Aeronautics and Space Administration (NASA); and the White House Office of Science and Technology Policy. FAA will have primary responsibility for implementing NGATS. This report addresses (1) the status of JPDO’s efforts to plan for NGATS, (2) the key challenges facing JPDO, and (3) the key challenges facing FAA as it implements the transformation. To address these issues, GAO reviewed relevant documents, interviewed agency officials and stakeholders, and conducted an expert panel.

What GAO Recommends

GAO recommends that JPDO institutionalize its practices for interagency collaboration and assess stakeholder involvement, and that FAA assess its needs for technical expertise. JPDO and FAA commented that they plan to consider GAO’s recommendations. NASA highlighted the impact of its refocused aeronautics research. GAO incorporated the other agencies’ technical comments as appropriate.

www.gao.gov/cgi-bin/getrpt?GAO-07-25.

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

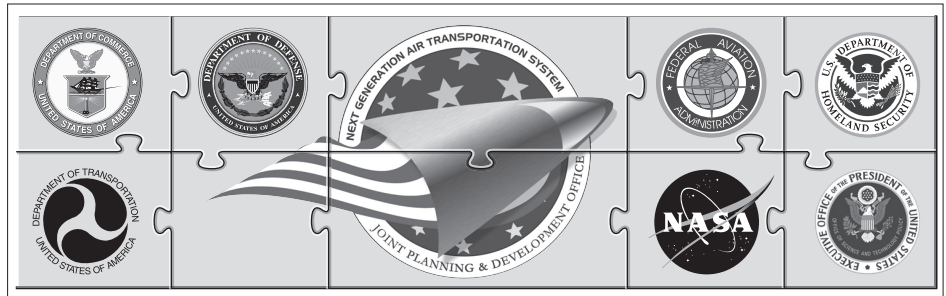
What GAO Found

JPDO has developed a framework for planning and coordinating with its partner agencies and nonfederal stakeholders that is consistent with its authorizing legislation and with several practices that GAO’s previous work has shown can facilitate federal interagency collaboration. JPDO’s partner agencies have agreed on a vision for NGATS and on eight strategies that broadly address the goals and objectives of NGATS. JPDO has been developing an enterprise architecture (or blueprint) for NGATS and plans to use the enterprise architecture and stakeholder input from investment analysis workshops to develop a realistic cost estimate for NGATS.

JPDO faces challenges in institutionalizing its collaborative effort, addressing planning and expertise gaps, establishing credibility with stakeholders, and harmonizing its work with other countries’ efforts to modernize their own air traffic management systems. To date, JPDO has not established some practices significant to institutionalizing its collaborative process, such as formalizing roles and responsibilities. Such practices are important because JPDO is fundamentally a planning and coordinating body that lacks authority over the key human and financial resources needed to continue developing plans and system requirements for NGATS.

FAA, as the key implementer of the transition to NGATS, faces challenges both in institutionalizing the management reforms that it has made in recent years that have contributed to its ability to meet its goals for air traffic control system acquisitions and in obtaining the financial and technical resources needed to implement NGATS. FAA also faces challenges in finding ways to reduce costs or realize savings to help fund the costs of transitioning to NGATS while continuing to operate and maintain the current system. Finally, FAA faces challenges in obtaining the technical and contract management expertise needed to define, implement, and integrate the numerous complex programs and systems inherent in the transition to NGATS.

Seven Partner Agencies Form the Joint Planning and Development Office



Source: GAO.

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Abbreviations

ADS-B	Automatic Dependent Surveillance-Broadcast
ATC	air traffic control
ATO	Air Traffic Organization
DHS	Department of Homeland Security
DOC	Department of Commerce
DOD	Department of Defense
DOT	Department of Transportation
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organization
IPT	integrated product team
JPDO	Joint Planning and Development Office
LSI	lead systems integrator
MOU	memorandum of understanding
NASA	National Aeronautics and Space Administration
NATCA	National Air Traffic Controllers Association
NGATS	Next Generation Air Transportation System
OMB	Office of Management and Budget
OSTP	White House Office of Science and Technology Policy
REDAC	Research, Engineering and Development Advisory Committee
SESAR	Single European Sky Air Traffic Management Research Programme
SWIM	System Wide Information Management

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United States Government Accountability Office
Washington, DC 20548

November 13, 2006

The Honorable Sherwood Boehlert
Chairman
The Honorable Bart Gordon
Ranking Minority Member
Committee on Science
House of Representatives

The Honorable Ken Calvert
Chairman
The Honorable Mark Udall
Ranking Minority Member
Subcommittee on Space and Aeronautics
Committee on Science
House of Representatives

While the health of the nation's air transportation system is critical to the economy, the current approach to managing air transportation is becoming increasingly inefficient and operationally obsolete. In 2003, Congress authorized the creation of the Joint Planning and Development Office (JPDO) to plan for and coordinate a transition from the nation's current air traffic control system to the "next generation air transportation system" (NGATS)—a system intended to safely accommodate a possible tripling of air traffic by 2025. NGATS is envisioned as a major redesign of the air transportation system that will entail precision satellite navigation; digital, networked communications; an integrated weather system; layered, adaptive security; and more. Vision 100,¹ the legislation that authorized JPDO, requires the office to operate in conjunction with multiple government agencies, including the Departments of Transportation, Commerce, Defense, and Homeland Security; the Federal Aviation Administration (FAA); the National Aeronautics and Space Administration (NASA); and the White House Office of Science and Technology Policy. Although JPDO is responsible for planning the transformation to NGATS and coordinating the related efforts of its partner agencies, FAA will be largely responsible for implementing the

¹Pub. L. No. 108-176, Vision 100—Century of Aviation Reauthorization Act, December 12, 2003.

policies and systems necessary for NGATS, while safely operating the current air traffic control system 24 hours a day, 7 days a week.

In light of the difficulty and importance of the tasks before JPDO and FAA, you asked us to review the efforts to organize and plan for NGATS. Accordingly, we addressed the following questions: (1) What is the status of JPDO's efforts to plan for NGATS? (2) What key challenges does JPDO face in moving forward with its planning efforts? (3) What key challenges does FAA face as it moves toward implementing NGATS?

To address the status of JPDO's efforts to plan for NGATS and the challenges that the office faces, we reviewed documents provided by JPDO and its partner agencies, including JPDO's December 2004 Integrated Plan, its 2005 Progress Report, and July 2006 draft Concept of Operations. We interviewed agency officials and stakeholders and convened a panel of experts to gather information and perspectives about the efforts of JPDO. We assessed the status and challenges of JPDO's framework for facilitating coordination among its partner agencies by comparing JPDO's efforts to date against selected key practices that we have reported can enhance and sustain federal collaborative efforts.² We selected five of eight practices as criteria for this review because they are significant to building the framework needed for any collaboration and are particularly important to JPDO at this early juncture in its collaborative efforts. The key practices used for this assessment include defining and articulating a common outcome, establishing mutually reinforcing or joint strategies, identifying and addressing needs by leveraging resources, agreeing on roles and responsibilities, and reinforcing agency accountability for collaborative efforts through agency plans and reports.³ We assessed JPDO's efforts to obtain the participation of nonfederal stakeholders by obtaining the perspectives of nonfederal stakeholders involved with JPDO and drawing on our body of work on stakeholder involvement. We assessed JPDO's technical planning efforts for NGATS by comparing JPDO's practices with those that we have found to be effective

²GAO, *Results-Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, [GAO-06-15](#) (Washington, D.C.: Oct. 21, 2005).

³The remaining three practices include establishing compatible policies, procedures, and other means to operate across agency boundaries; developing mechanisms to monitor, evaluate, and report on results; and reinforcing individual accountability for collaborative efforts through performance management systems.

in developing enterprise architectures.⁴ One of our senior-level technologists also reviewed JPDO's draft Concept of Operations. We also obtained information on an estimate of FAA's future costs under NGATS but did not review in detail the methodology or assumptions used to develop this estimate. To understand JPDO's and FAA's efforts to date on global harmonization, we met with European officials and reviewed documents related to Europe's concurrent air transportation modernization effort, known as the Single European Sky Air Traffic Management Research Programme (SESAR). To determine the challenges that FAA faces in implementing NGATS, we met with agency officials, reviewed documentation related to FAA's modernization efforts, and drew upon our prior work examining FAA's program to modernize the National Airspace System. We conducted our work between July 2005 and September 2006 in accordance with generally accepted government auditing standards. See appendix I for a more detailed explanation of our scope and methodology. A detailed discussion of the results of our expert panel is contained in appendix II.

Results in Brief

JPDO has developed a framework for planning and coordination with its partner agencies and nonfederal stakeholders that is consistent with the requirements of Vision 100 and with several practices that our previous work has shown can facilitate federal interagency collaboration and enterprise architecture development. JPDO and its partner agencies have developed an Integrated Plan and reported on the progress of that plan as called for in Vision 100. In working to develop the Integrated Plan, the partner agencies agreed on a vision for NGATS and on eight strategies that broadly address the goals and objectives of NGATS—actions consistent with effective collaborative practices that we have identified. JPDO has also established an organizational structure that involves federal and nonfederal stakeholders throughout the organization. To leverage human resources, JPDO has staffed the various levels of its organization with partner agency employees, many of whom work part time for JPDO. To leverage technological resources, JPDO has sought to coordinate NGATS-related programs across the partner agencies. JPDO identified early

⁴An enterprise architecture is a tool, or blueprint, for understanding and planning complex systems. JPDO anticipates that the NGATS enterprise architecture will provide the means for coordinating among the partner agencies and private sector manufacturers, aligning relevant research and development activities, and integrating equipment. See GAO, *Federal Aviation Administration: Stronger Architecture Program Needed to Guide Systems Modernization Efforts*, [GAO-05-266](#) (Washington, D.C.: Apr. 29, 2005).

opportunities that could be pursued during fiscal year 2007 to minimize the duplication of research programs across agencies and to produce tangible results for NGATS. JPDO has been developing an enterprise architecture (or blueprint)—one of the most critical planning documents in the NGATS effort—and has taken several steps consistent with effective practices that we have identified for enterprise architecture development. JPDO expects the enterprise architecture to provide more clarity regarding its expectations for NGATS, thereby facilitating coordination among the partner agencies and private sector manufacturers, alignment of relevant research and development activities, and integration of equipment. The enterprise architecture is also critical to the development of realistic cost estimates for NGATS. Without such realistic cost estimates, Congress is handicapped in its planning for the funding needs of NGATS. To this end, JPDO has also begun working with its stakeholders to develop initial cost information through a series of investment analysis workshops. Finally, JPDO recognizes the importance of global harmonization of air transportation technologies and systems and has begun work to ensure that the NGATS effort is harmonized with the European SESAR effort and with the efforts of other regions.

JPDO faces challenges in institutionalizing its collaborative effort, addressing planning and expertise gaps, establishing credibility with stakeholders, and harmonizing its work with other countries' efforts to modernize their own air traffic management systems. JPDO is fundamentally a planning and coordinating body that lacks authority over the key human and technological resources needed to continue developing plans and system requirements for NGATS. To date, JPDO has not established some practices significant to institutionalizing the collaborative process. For example, JPDO does not have formal, long-term agreements among the partner agencies on their roles and responsibilities in creating NGATS. JPDO has been working to establish a memorandum of understanding (MOU) with its partner agencies since at least August 2005, but the MOU had not been signed as of September 2006. JPDO also currently lacks explicit policies and procedures for decision making and dispute resolution and has not yet completed mechanisms for leveraging partner agency resources. To its credit, JPDO has been working with the Office of Management and Budget (OMB) to develop a means to consider NGATS-related funding, dispersed across JPDO's partner agency budget requests, as a unified federal program. Nonetheless, given JPDO's limited authority, the office could face challenges in sustaining the lengthy and elaborate federal collaborative effort set forth by Vision 100 without full development of procedures and mechanisms for dispute resolution and leveraging of resources. JPDO also faces challenges with some planning

and expertise gaps. For example, NASA is moving toward a focus on fundamental research and away from demonstration projects. Many experts told us that this creates a gap in technology development. This raises the question of what entity will do the developmental work that will be important to NGATS. According to JPDO officials, they are conducting a gap analysis on the impact of NASA's actions on NGATS planning. Also important to NGATS is the involvement of all key stakeholders in the planning process, yet some stakeholders, such as active air traffic controllers, are not currently involved with JPDO. Our work on past air traffic control modernization projects has shown that a lack of stakeholder involvement early and throughout a project has been a key factor that leads to cost increases and delays. As noted by our expert panel, JPDO also faces challenges in establishing credibility among stakeholders. For example, some members of our expert panel told us that, although JPDO has produced much activity, they did not feel the effort had demonstrated sufficient progress; some stakeholders told us that both the 2004 Integrated Plan and the 2005 Progress Report lacked sufficient detail, such as definition of research needs. Finally, JPDO faces challenges in achieving global harmonization for NGATS. While FAA and the European Commission recently signed an MOU to ensure cooperation between the aviation modernization programs in the United States and Europe, much work remains in carrying out that agreement and in addressing harmonization throughout other regions of the world.

FAA, as the key implementer of the transition to NGATS, faces challenges both in institutionalizing the management reforms that it has made in recent years, which have contributed to its ability to meet its goals for ATC acquisitions, and in obtaining the financial and technical resources needed to implement NGATS. Since 1995, we have designated FAA's air traffic control modernization program as high risk because of systemic management and acquisition problems. FAA has recently taken a number of actions aimed at improving its management practices, including a focus on implementing more businesslike management and acquisition processes. FAA has also taken steps to institutionalize these improvements by ensuring that the reforms are fully integrated into the agency's structure and processes at all levels and have become part of its organizational culture. However, transforming organizational cultures requires substantial management attention, as it can take several years for such initiatives to be fully implemented and cultures transformed in a sustainable manner. FAA also faces challenges in finding ways to reduce costs or realize savings to help fund the costs of transitioning to NGATS while continuing to operate and maintain the current system. FAA is working to reduce costs by streamlining its operations and could realize

savings in operating costs from the implementation of some NGATS technologies. Finally, FAA faces challenges in obtaining the expertise needed to implement a system as complex as NGATS. Recognizing the complexity of the NGATS implementation effort and the possibility that FAA may not have the in-house expertise to manage it without assistance, we have identified potential approaches for supplementing FAA's capabilities. Approaches include contracting with a lead systems integrator or obtaining technical advice from a federally funded research and development corporation. FAA has not yet formally explored its strengths and weaknesses with regard to the technical expertise and contract management expertise that will be required of it to define, implement, and integrate the numerous complex programs and systems inherent in the transition to NGATS.

We are recommending that the Secretary of Transportation direct JPDO to take actions to institutionalize the partner agencies' collaboration in supporting NGATS, including action on an MOU among the partner agencies, actions to finalize procedures to leverage partner agency resources, and actions to develop procedures for dispute resolution. We are also recommending that the Secretary direct JPDO to determine whether key stakeholders and expertise are not currently represented in JPDO planning efforts. Finally, we are recommending that the Secretary direct FAA to undertake a formal exploration of the technical expertise and contract management expertise that will be required by FAA to implement NGATS.

We provided a draft of this report to the Departments of Commerce, Defense, Homeland Security, and Transportation; FAA; JPDO; NASA; and the White House Office of Science and Technology Policy for their review and comment. NASA's written comments are included as appendix IV. NASA agreed with the majority of the report's content, but highlighted specific points about (1) the impact of its recent emphasis on fundamental aeronautics, (2) NASA's role in developing NGATS, and (3) NASA's fiscal year 2007 request for aeronautics research funding. Transportation, FAA, JPDO, Homeland Security, and the Office of Science and Technology Policy provided technical clarifications and additional information, which we incorporated into this report as appropriate. FAA and JPDO neither agreed nor disagreed with our recommendations, but said they would consider them. Commerce and Defense had no comments on the draft report.

Background

JPDO began operating in early 2004 and is housed within FAA. JPDO's Director reports to the FAA Administrator and to the FAA Chief Operating

Officer (head of FAA's Air Traffic Organization [ATO]). The scope of JPDO's effort is broader than that of traditional air traffic control modernization in that it is "airport curb to airport curb," encompassing such issues as security screening and environmental concerns. Additionally, JPDO's approach will require unprecedented collaboration and consensus among many stakeholders—federal and nonfederal—about necessary system capabilities, equipment, procedures, and regulations. JPDO has identified roles for each of its partner agencies in the transformation to NGATS. For example, the Department of Defense has deployed "network centric" systems,⁵ originally developed for the battlefield, that are being considered as a conceptual framework to provide all users of the National Airspace System—FAA and the Departments of Defense and Homeland Security—with a common view of that system.

Since its inception, JPDO has focused on establishing an organizational framework to carry out the interagency planning mandate contained in Vision 100, while ensuring participation of nonfederal stakeholders and the general public. JPDO has also reviewed the research projects of its partner agencies to identify work that aligns with NGATS' needs and has issued budget guidance to these agencies to highlight the areas where each agency could contribute to implementing NGATS. JPDO currently has several key NGATS planning documents in various stages of development.

JPDO Has Made Progress in Planning for NGATS

Many of JPDO's actions are consistent with practices that our work has shown facilitate interagency collaboration—a key factor in the future success of NGATS. JPDO is also developing an enterprise architecture—a key document for NGATS planning—using a phased approach that is similar to a process we have advocated for FAA's major systems acquisition programs and anticipates having a first draft in by the end of 2006. Although a preliminary estimate exists of FAA's costs to implement NGATS, further work is needed to develop a comprehensive understanding of NGATS costs.

⁵Network centric systems aim to exploit technical advances in information technology and telecommunications to improve situational awareness and the speed of decision making.

As Required by Vision 100, JPDO Developed an Integrated Plan and Reported on the Progress of That Plan

Vision 100 calls for JPDO to develop an integrated plan for NGATS and provide annual updates on the progress of that plan. JPDO, with its partner agencies, developed an NGATS Integrated Plan and submitted it to Congress on December 12, 2004. The plan includes a vision statement for a system capable of handling a threefold increase in demand for air transportation by 2025. The vision entails providing services tailored to individual customer needs, allowing all communities to participate in the global economy, and seamlessly integrating civil and military operations. The partner agencies also agreed on eight strategies that broadly address the goals and objectives for NGATS. In March 2006, JPDO published its first report to Congress on the progress made in carrying out the NGATS Integrated Plan.

In addition to complying with Vision 100's mandate, developing an integrated plan is consistent with effective collaborative practices we have identified.⁶ According to our research on federal interagency collaborations, agencies must have a clear and compelling rationale for working together to overcome significant differences in their missions, cultures, and established ways of doing business. JPDO's partner agencies have a diverse set of missions, ranging from national defense to the promotion of commerce. Yet each has some involvement in the air transportation system and can make a contribution to NGATS. In working together to develop JPDO's Integrated Plan, the partner agencies agreed on a vision statement to transform the air transportation system and on broad statements of future system goals, performance characteristics, and operational concepts.

JPDO Developed an Organization for Involving Federal and Nonfederal Stakeholders

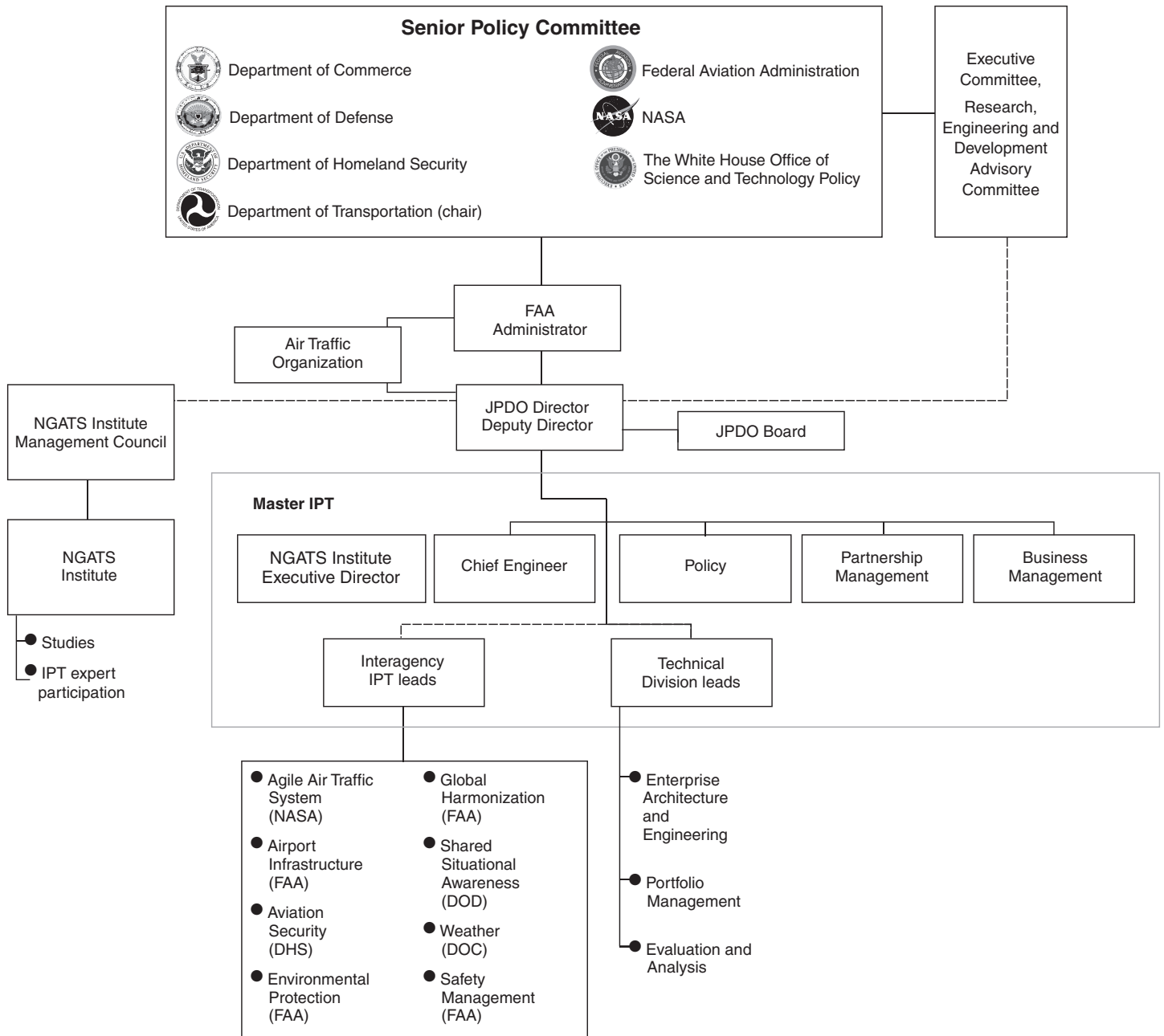
Vision 100 includes requirements for JPDO to coordinate and consult with its partner agencies, private sector experts, and the public. JPDO's approach has been to establish an organizational structure that involves federal and nonfederal stakeholders throughout the organization. This structure includes a federal interagency senior policy committee, an institute for nonfederal stakeholders, and eight integrated product teams (IPT) that bring together federal and nonfederal experts to plan for and coordinate the development of technologies that will address JPDO's eight broad strategies.

⁶[GAO-06-15](#).

JPDO's senior policy committee is headed by the Secretary of Transportation (as required in Vision 100) and includes senior-level officials from JPDO's partner agencies. It has met three times since its inception. The NGATS Institute (the Institute) was created by an agreement between the National Center for Advanced Technologies⁷ and FAA to incorporate the expertise and views of stakeholders from private industry, state and local governments, and academia. The NGATS Institute Management Council, composed of top 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 NGATS issues. To meet Vision 100's requirement that JPDO coordinate and consult with the public, the Institute held its first public meeting in March 2006. The IPTs are headed by representatives of JPDO's partner agencies and include more than 200 nonfederal stakeholders from over 100 organizations, whose participation was arranged through the Institute. Figure 1 illustrates JPDO's position within FAA and the JPDO structures that bring together federal and nonfederal stakeholders, including the Institute and the IPTs.

⁷The National Center for Advanced Technologies is a nonprofit unit within the Aerospace Industries Association.

Figure 1: Organization of JPDO



Source: JPDO.

Note: Department of Commerce = DOC; Department of Defense = DOD; Department of Homeland Security = DHS.

JPDO’s organizational structure incorporates some of the practices that we have found to be effective for federal interagency collaborations. For example, our work has shown that mutually reinforcing or joint strategies can help align partner agencies’ activities, core processes, and resources to accomplish a common outcome. Each of the eight IPTs is aligned with one of the eight strategies outlined in JPDO’s Integrated Plan, and each is headed by a partner agency that has taken the lead on a specific strategy (see table 1). Our research has also found that collaborating agencies should identify the resources needed to initiate or sustain their collaborative effort. To leverage human resources, JPDO has staffed the various levels of its organization—including JPDO’s board, the IPTs, and technical divisions—with partner agency employees, many of whom work part time for JPDO. Finally, our work has shown that involving stakeholders can, among other things, increase their support for a collaborative effort. The Institute provides a method for involving nonfederal stakeholders, including the public, in planning NGATS.

Table 1: JPDO’s Strategies and Related IPT Lead Agencies

Strategy	Related IPT Lead Agency
Develop airport infrastructure to meet future demand	Federal Aviation Administration
Establish an effective security system without limiting mobility or civil liberties	Department of Homeland Security
Establish an agile air traffic system that quickly responds to shifts in demand	National Aeronautics and Space Administration ^a
Establish shared situational awareness—where all users share the same information	Department of Defense
Establish a comprehensive and proactive approach to safety	Federal Aviation Administration
Develop environmental protection that allows sustained aviation growth	Federal Aviation Administration
Develop a systemwide capability to reduce weather impacts	Department of Commerce
Harmonize equipment and operations globally	Federal Aviation Administration

Sources: GAO and JPDO.

^aNASA leads this IPT because it has primary responsibility for conducting the necessary research; implementation of the agile air traffic system is the responsibility of FAA.

JPDO Has Begun to Leverage the Resources of Its Partner Agencies

Vision 100 requires JPDO to coordinate NGATS-related programs across the partner agencies. To address this requirement, JPDO conducted an initial review of its partner agencies’ research and development programs during July 2005 to identify work that could support NGATS. Through this

process, JPDO identified early opportunities that could be pursued during fiscal year 2007 to coordinate and minimize the duplication of research programs across the partner agencies and produce tangible results for NGATS. For example, one such opportunity involves aligning aviation weather research across FAA, NASA, and the Departments of Commerce and Defense, developing a common weather capability, and integrating weather information into NGATS decision systems. In addition, FAA's Automatic Dependent Surveillance-Broadcast (ADS-B)⁸ and System Wide Information Management (SWIM)⁹ programs were identified as opportunities to receive accelerated funding to begin producing tangible results for NGATS.

JPDO's efforts to leverage its partner agencies' resources for NGATS demonstrates another practice important to sustaining collaborations. Our work on collaborations has found that collaborating agencies, by assessing their relative strengths and limitations, can identify opportunities for leveraging each others' resources and thus obtain benefits that would not be available if they were working separately. JPDO's first interagency review of its partner agencies' research and development programs was a step toward leveraging technological resources for NGATS.

Consistent with Vision 100, JPDO Is Developing an Enterprise Architecture

Vision 100 requires JPDO to create "a multiagency research and development roadmap" for the transition to NGATS. To comply with this requirement, JPDO has been developing an enterprise architecture—one of the most critical planning documents in the NGATS effort. An enterprise architecture is 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 NGATS. JPDO intends for the enterprise architecture to describe FAA's operation of the current National Airspace System, JPDO's plans for NGATS, and the sequence of steps needed for

⁸ADS-B is a surveillance technology that transmits an aircraft's identity, position, velocity, and intent to other aircraft and to ATC systems on the ground, thereby enabling pilots and controllers to have a common picture of airspace and traffic. By providing pilots with a display that shows the location of nearby aircraft, the system enables pilots to collaborate in decision making with controllers, safely allowing reduced aircraft separation and thereby increasing capacity within the National Airspace System.

⁹SWIM is expected to help in the transition to network centric operations by providing the infrastructure and associated policies and standards to enable information sharing among all authorized system users, such as the airlines, civilian government agencies, and the military.

the transformation to NGATS. JPDO expects the enterprise architecture to provide more clarity regarding its expectations for NGATS, thereby facilitating coordination among the partner agencies and private sector manufacturers, the alignment of relevant research and development activities, and the integration of equipment. Many of JPDO's future activities will depend on the robustness and timeliness of this architecture development.

JPDO has taken several important steps to work toward the development of a mature enterprise architecture.¹⁰ For example, JPDO has drafted a Concept of Operations—a higher-level document that describes how NGATS will operate in 2025.¹¹ JPDO has used this document to identify key research and policy issues for NGATS, such as those associated with automating the air traffic control (ATC) system, including the need for a backup plan in case automation fails, the responsibilities and liabilities of different stakeholders during an automation failure, and the level of monitoring needed by pilots when automation is ensuring safe separation between aircraft. JPDO officials are currently incorporating stakeholders' comments into the Concept of Operations.

Another step that JPDO has taken to develop the enterprise architecture is to form an Enterprise Architecture and Engineering Division. JPDO has established and filled a chief architect position and established an NGATS Architecture Council composed of representatives from each partner agency's chief architect office. This type of organizational structure is consistent with effective practices that we have identified in enterprise architecture development. Similarly, JPDO has established an Evaluation and Analysis Division that is assembling a suite of models to help JPDO refine its plans for NGATS and iteratively narrow the range of potential solutions. For example, the division has used modeling to begin studying

¹⁰We have developed an Enterprise Architecture Management Maturity Framework. This framework outlines steps toward achieving a stable and mature process for managing the development, maintenance, and implementation of enterprise architectures. See GAO, *Information Technology: A Framework for Assessing and Improving Enterprise Architecture Management (Version 1.1)*, [GAO-03-584G](#) (Washington, D.C.: Apr. 1, 2003).

¹¹According to standards of the Institute of Electrical and Electronics Engineers, Inc. (IEEE), a Concept of Operations is a user-oriented document that describes the characteristics of a proposed system from the user's viewpoint. Among other things, the key elements that should be included in a Concept of Operations are major system components, interfaces to external systems, and performance characteristics such as speed and capacity.

how possible changes in the duties of some key personnel could affect the workload and performance of others.

To develop and refine the enterprise architecture for NGATS, JPDO plans to follow a phased, “build a little, test a little” approach. This approach is similar to a process we have advocated for FAA’s major system acquisition programs. While JPDO expects the first draft of its enterprise architecture to be issued by the end of this calendar year, officials anticipate that it will be further refined based on stakeholder comments. This phased approach will also allow JPDO to incorporate evolving market forces and technologies into its architecture and thus better manage change.

The Existing Cost Estimate for NGATS Is Incomplete

Understanding the costs involved in the transition to NGATS is critical to the NGATS planning effort, yet no comprehensive estimation of these costs has been developed. This cost information is particularly important to Congress, which will have the authority to make NGATS funding decisions. To begin estimating NGATS costs, JPDO is holding a series of investment analysis workshops with stakeholders. Representatives from commercial and business aviation, equipment manufacturers, and ATC systems developers attended the first workshop, held in April 2006. The second workshop, held in August 2006, was for those involved with general aviation and public safety operations. JPDO plans to invite representatives from airports and regional, state, and local planning bodies to the third workshop. According to JPDO, participants in these workshops are asked to discuss and comment on the appropriateness of JPDO’s current assumptions about factors that drive private sector costs.

Although JPDO expects that these workshops will provide information to be used in developing a range of potential costs for NGATS, an enterprise architecture is needed to further define and better understand how a number of factors will drive NGATS costs. One of these drivers is the decision about which technologies to include in NGATS. Some of these technologies are more complex and thus more expensive to implement than others. A second driver is the sequence for replacing current technologies with NGATS technologies. A third driver is the length of time required for the transformation to NGATS, since, according to JPDO, a longer period would impose higher costs. JPDO’s first draft of its enterprise architecture could reduce some of these variables, thereby allowing improved estimates of NGATS’ costs.

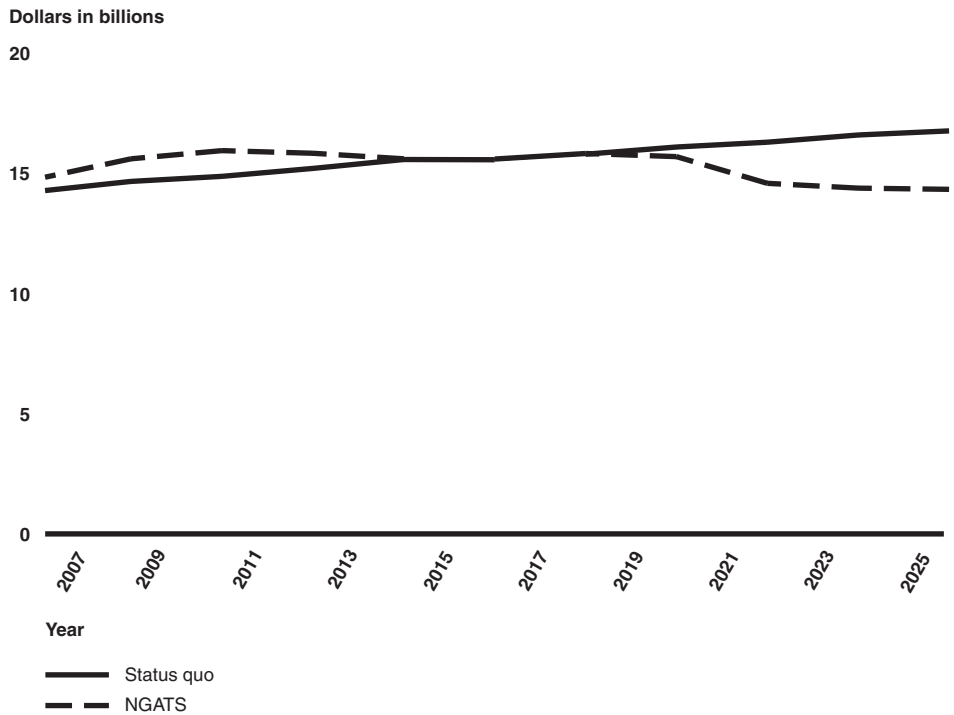
While JPDO is beginning to explore the issue of cost estimates for NGATS, an advisory committee to FAA—the Research, Engineering and

Development Advisory Committee (REDAC)—has developed a limited, preliminary cost estimate, which officials have emphasized is not yet endorsed by any agency.¹² REDAC estimated that FAA’s budget under an NGATS scenario would average about \$15 billion per year through 2025, or about \$1 billion more annually (in today’s dollars) than FAA’s fiscal year 2006 appropriation. REDAC estimated that the cost for a status quo scenario (i.e., no NGATS) would also be about \$15 billion per year through 2025.¹³ These estimates came out roughly equal, on average, because future FAA spending would be higher under NGATS than the status quo scenario in the early years but lower than under the status quo toward 2025 (see fig. 2). This relationship is due primarily to the expectation that, under the NGATS scenario, capital expenditures would be higher than under the status quo scenario in the near term, but operations costs would be lower because of productivity improvements in the longer term. Moreover, the NGATS cost estimate assumes that capital costs decrease sharply toward 2025. Officials who developed this estimate explained that the estimate treats NGATS as an isolated event. In reality, these officials acknowledge that planning for the subsequent “next generation” system will likely be under way as 2025 approaches, and the actual modernization costs could, therefore, be higher in this time frame than the estimate indicates.

¹²In developing its estimate, REDAC used FAA’s projected facilities and equipment costs under an NGATS scenario, as well as REDAC’s own estimates for the costs of operations; research, engineering, and development; and airport improvements—the remaining three components of FAA’s appropriation.

¹³In this report, we describe REDAC’s “base case” scenarios, which assumed that FAA’s operations costs would increase between 2006 and 2010 but then remain constant through 2025 (except for inflation), as productivity increases offset the higher cost of increased demand. REDAC also developed estimates for lower-cost “best case” and higher-cost “worst case” scenarios using differing assumptions of productivity gains.

Figure 2: REDAC's Funding Estimates for FAA under Status Quo and NGATS Scenarios, 2006-2025



Sources: GAO and REDAC.

Note: Estimated costs shown in constant 2005 dollars.

In addition, this estimate should be viewed within the context of a number of factors. First, REDAC does not believe that maintaining the status quo is a viable option because it would provide insufficient capacity to meet projected future demand. REDAC stated that it presented the status quo option “for analytical purposes only since the current approach to air traffic control and management in use in the United States cannot be scaled up to handle the projected growth in traffic.” In fact, JPDO has estimated the annual economic cost of not meeting future demand; by 2020, JPDO estimates this cost at \$40 billion per year. Second, the REDAC estimate does not include the costs of the intermediate technology development work, performed to date by NASA. As discussed later in this report, it is currently unclear which entities will perform this work.

Last, and most important, this estimate was developed before JPDO completed important planning documents and does not include estimates of the other partner agencies’ costs of implementing NGATS. An early

version of JPDO's Concept of Operations for NGATS was released for stakeholder comment only this past July, and the initial draft of the enterprise architecture has yet to be released. Both of these documents will have to be synchronized with JPDO's Operational Improvement Roadmaps, which will describe the timing of the implementation of various NGATS systems. The draft Concept of Operations states that several topics, including safety management and regulation, will be addressed in later iterations of the document. Similarly, JPDO plans to first release a version of the enterprise architecture that addresses only the "block to block"—that is, the air traffic management—aspects of NGATS. A "curb to curb" enterprise architecture, which would include security, is not expected until around the middle of 2007. Thus, REDAC's estimate does not include the other partner agencies' costs to implement NGATS, such as those that the Department of Homeland Security might incur to develop and implement new security technologies. In addition to including partner agency costs in the estimate, other costs, such as those for training of personnel in new technologies, must be further explored.

JPDO Recognizes the Importance of Global Harmonization and Has Begun Harmonization Activities

Concurrent with JPDO's efforts, the European Commission is conducting a project, known as SESAR, to harmonize and modernize the European air traffic management system. The project is overseen by the European Organization for the Safety of Air Navigation (Eurocontrol). Eurocontrol has contracted out the work of SESAR to a 30-member consortium of airlines, air navigation service providers, airports, manufacturers, and others. See appendix III for a more detailed description of SESAR.

American and European aviation officials have recognized the importance of harmonization—that is, of adopting equivalent performance standards and technologies that will make their equipment interoperable. Vision 100 calls for NGATS to enable seamless global operations, and JPDO officials have acknowledged that different and incompatible standards and technologies, if implemented, could have a major adverse impact on airlines that serve international markets. In working toward harmonization, personnel exchanges between Europe and the United States have begun, and FAA is a member of a group that advises the industry consortium that manages SESAR under a preexisting MOU between Eurocontrol and FAA. In addition, FAA and the European Commission signed another MOU in July 2006 to establish a framework for ensuring cooperation in working toward a more common global air traffic management system.

JPDO Faces Institutionalization, Planning, Commitment, and Interoperability Challenges as It Moves Forward with NGATS

JPDO faces a challenge in institutionalizing the interagency collaborative process with its partner agencies. Some planning and expertise gaps exist, including technology development, human factors research, and the participation of key stakeholders. JPDO faces challenges in convincing stakeholders of the credibility of its effort and of the government's commitment to the NGATS effort. JPDO also faces challenges related to harmonizing NGATS with modernization efforts taking place in other countries.

Institutionalizing the Collaborative Process Poses a Challenge for JPDO

Although JPDO's legislation, Integrated Plan, and established governance structure provide the framework for collaborating among multiple federal agencies, JPDO is fundamentally a planning and coordinating body that lacks authority over the key human and technological resources needed to continue developing plans and system requirements for NGATS. Consequently, institutionalizing the collaborative process with its partner agencies will be critical to JPDO's ability to leverage the necessary funding for developing NGATS. Institutionalizing the collaborative process means that, as administrations and staffing within JPDO change over the years, those coming into JPDO will have a clear understanding of what is expected of them and of the time and resource commitments entailed.

To date, JPDO has not established practices significant to institutionalizing the collaborative process. For example, our work on effective collaboration practices has shown that collaborating agencies should work together to define and agree on their respective roles and responsibilities. At a fundamental level, JPDO does not have formal, long-term agreements among the partner agencies on their roles and responsibilities in creating NGATS. Additionally, some stakeholders with whom we spoke noted that several IPTs are still struggling to define their roles and responsibilities in developing NGATS. Presently, there is no mechanism that assures that the partner agencies' commitment will continue over the 20-year time frame of NGATS or that ensures accountability to JPDO. According to JPDO officials, they are working to establish an MOU, signed by the Secretary or other high-ranking official from each partner agency, which will broadly define the partner agencies' roles and responsibilities. However, JPDO first informed us of the development of the MOU in August 2005 and, as of September 2006, the MOU had not been finalized.

Defining roles and responsibilities is particularly important between JPDO and FAA's ATO, since both organizations have responsibilities related to planning national airspace system modernization. ATO has primary responsibility for the ATC system's current and near-term modernization, while JPDO has responsibility for planning and coordinating a transformation to NGATS over the next 20 years. Some stakeholders have expressed concern that the relationship between JPDO's and ATO's efforts is not clear. Some of our expert panelists felt that a "gap" plan should be developed to identify areas that might fall between ATO's efforts to maintain the current system and JPDO's plans for the future. According to JPDO and ATO officials, the roles and responsibilities of each office are currently being worked out.¹⁴ ATO now plans to expand its Operational Evolution Plan—to be renamed the Operational Evolution Partnership—so that it applies FAA-wide and represents FAA's piece of JPDO's overall NGATS plan.¹⁵ In essence, ATO intends for the Operational Evolution Partnership to become FAA's implementation plan for NGATS. Without continued focus on clarifying and institutionalizing the relationship between ATO and JPDO, it is more difficult to ensure continued progress toward NGATS, particularly with the FAA Administrator's and ATO Chief Operating Officer's terms ending within the next 2 years.

In addition to not having clearly defined the roles and responsibilities of the various federal and nonfederal participants, JPDO also currently lacks explicit policies and procedures for decision making and dispute resolution. Our collaboration work shows that in defining and agreeing on roles and responsibilities, the collaborating agencies should also establish how the collaborative effort will be led; this establishment of leadership facilitates decision making for the collaboration. According to JPDO officials, the senior policy committee makes decisions through consensus of the members. If there are any issues that the committee cannot resolve among themselves, JPDO officials said that they would expect that the Secretary of Transportation would elevate those issues to the appropriate White House-level policy council, such as the Domestic Policy Council. However, without documented policies or procedures on the decision

¹⁴The FAA order establishing JPDO directs JPDO to, among other things, report to ATO's Chief Operating Officer for day-to-day management oversight and integration into the National Airspace System.

¹⁵Currently, FAA's Operational Evolution Plan monitors how NAS capacity will change over a rolling 10-year planning horizon depending on numerous variables, such as the demand for air travel, the completion of new runways, and the availability of new ATC systems. It has also focused on the building capacity at 35 large hub airports.

making and dispute resolution processes for the senior policy committee and the JPDO board, there is no clear understanding of the process and no institutionalized approach to carry forward as members of the senior policy committee and board change over time.

Another mechanism for institutionalizing the collaborative process is to use the agencies' strategic and annual performance plans as tools to establish complementary goals and strategies for achieving results. Based on our assessment of the partner agencies' strategic plans, we found that only the Department of Transportation, NASA, and FAA have incorporated NGATS goals into their strategic plans. Thus, more opportunities may exist for integrating NGATS goals into the partner agencies' plans and budgets. One example of such integration is NASA's current reauthorization act, which requires the agency to align its aviation research projects to directly support NGATS goals. NASA has now focused one of its research programs specifically on the needs of NGATS and JPDO.

Finally, JPDO has not completed mechanisms for leveraging partner agency resources—an important practice for sustaining collaborations and an issue that JPDO officials view as one of their greatest challenges. JPDO has been working with OMB to develop a process for identifying “NGATS-related projects” across the various agencies. This process would allow OMB to consider NGATS-related projects as a unified program going forward and to make funding decisions accordingly. According to JPDO officials, leveraging efforts have worked well so far, but JPDO's need for resources and expertise will increase with the development of NGATS. One expert with whom we spoke noted that the real heavy lifting for JPDO was still ahead because developing a step-by-step, detailed implementation plan will be much more resource intensive than the development of the vision for NGATS has been to date. Also, JPDO could face difficulties in securing needed agency resources if the priorities of the partner agencies change over time, as all of the JPDO partner agencies have a variety of missions and priorities in addition to NGATS. For example, according to the President's proposed fiscal year 2007 budget and NASA's current plans, space exploration activities, including research and development, will continue to be the largest part of NASA's budget in the future. This trend will be driven by the development of a replacement vehicle for the space shuttle, manned lunar exploration, and robotic and manned Mars exploration missions. In contrast, funding for aeronautics research within NASA is projected to decline through at least fiscal year 2011.

JPDO Faces Challenges in Addressing Planning and Expertise Gaps

Technology Development and Technology Transfer

In the early stages of JPDO's efforts, gaps in planning and expertise have emerged. JPDO may face challenges in addressing these gaps because of its lack of authority over partner agencies' resources and expertise.

Our analysis of NASA's aeronautics research budget shows a 30 percent decline, in constant 2005 dollars, from 2005 to 2011. To its credit, given the reduced resources available for aeronautics, NASA plans to address the research and development needs of NGATS. However, NASA is also moving toward a focus on fundamental aeronautical research¹⁶ and away from demonstration projects.¹⁷ Many experts told us that NASA's new focus on fundamental research creates a gap in the technology development continuum.¹⁸ As we have reported, NASA's current plans might leave technologies too underdeveloped for easy transfer to industry and raises the question of what entity will do this developmental work.¹⁹ Some believe that FAA has neither the research and development infrastructure nor the funding to do this work. According to a draft report by REDAC, FAA would need at least \$100 million annually in increased funding to perform this research and development work, and establishing the necessary infrastructure within FAA could delay the implementation of NGATS by 5 years. According to JPDO officials, they are conducting a gap analysis on the impact of NASA's actions on NGATS planning. We believe that such an analysis, as well as finding a solution if needed, are critically important steps.

Human Factors Research

Addressing human factors issues is another key challenge for JPDO. For example, NGATS Concept of Operations envisions an increased reliance

¹⁶NASA defines fundamental research as that research that includes continued, long-term scientific study in areas such as physics, chemistry, materials, experimental techniques, and computational techniques that leads to a furthering of understanding of the underlying principles that form the foundation of the core aeronautics disciplines, as well as that research that integrates the knowledge gained in these core areas to significantly enhance capabilities, tools, and technologies at the disciplinary (e.g., aerodynamics, combustion, dynamics and control, acoustics) and multidisciplinary (e.g., engine design, airframe design) level.

¹⁷NASA noted that it will still conduct flight test experiments across most of the projects in its portfolio.

¹⁸In focusing on fundamental research, NASA does not plan to develop new technologies to the same level of maturity as in the past.

¹⁹GAO, *U.S. Aerospace Industry: Progress in Implementing Aerospace Commission Recommendations, and Remaining Challenges*, GAO-06-920 (Washington, D.C.: Sept. 13, 2006).

on automation, which raises questions about the role of the air traffic controller in such an automated system. Similarly, the Concept of Operations envisions that pilots will take on a greater share of the responsibility for maintaining safe separation and other tasks currently performed by controllers. This raises human factors questions about whether pilots can safely perform these additional duties. Although JPDO has begun to model how shifts in air traffic controllers' workloads would affect their performance, it has not yet begun to model the effect of how this shift in workload to pilots would affect pilot performance. According to a JPDO official, modeling the effect of changes in pilot workload has not yet begun because JPDO has not yet identified a suitable model for incorporation into its suite of modeling tools. According to JPDO, the change in the roles of pilots and controllers is the most important human factors issue involved in creating NGATS but will be difficult to research because data on pilot behavior are not readily available for use in creating models. In addition to the study of changing roles, JPDO has not yet studied the training implications of various systems or solutions proposed for NGATS. For example, JPDO officials said they will be able to study the extent to which new air traffic controllers will have to be trained to operate both the old and the new equipment as the Concept of Operations and enterprise architecture mature.

Absence of Key Stakeholder Involvement

Some stakeholders, such as current air traffic controllers, will play key roles in NGATS but are not currently involved in the NGATS planning effort. JPDO officials believe that they have sufficient expertise involved in the NGATS effort at this time because some participants have prior experience as air traffic controllers. However, one stakeholder with whom we spoke said that controllers need to be part of the NGATS effort now because their expertise extends beyond equipment configuration to issues involving the NGATS vision and Concept of Operations. Similarly, a member of our expert panel expressed concern that planning for NGATS would be unsuccessful without controller participation. The input of current air traffic controllers who have recent experience controlling aircraft is important in considering human factors and safety issues because of the controllers' familiarity with existing operating conditions. Our work on past air traffic control modernization projects has shown that a lack of stakeholder or expert involvement early and throughout a project can lead to cost increases and delays.

The air traffic controllers' labor union, the National Air Traffic Controllers Association (NATCA), has not participated in NGATS since June 2005 when FAA terminated a labor liaison program that assigned air traffic controllers to major system acquisition program offices and to JPDO. FAA

had determined that the benefits of the program were not great enough to justify its cost. Nonetheless, several stakeholders who serve on the Institute Management Council and the IPTs said they were concerned about the lack of air traffic controller involvement with JPDO. The NGATS Institute Management Council includes a seat for the union, but a NATCA official told us that the union's head had been unable to attend the council's meetings. According to JPDO officials, the council has left a seat open in hopes that the controllers will participate in NGATS as the new labor-management agreement between NATCA and FAA is implemented. Additionally, an official with the Institute noted that the council plans to reach out to the air traffic controllers in an attempt to obtain their future participation.

Establishing Credibility with Stakeholders That the Government Is Fully Committed to NGATS Presents a Challenge

Establishing credibility was viewed by the majority of our expert panelists as the primary challenge facing JPDO. This view partially stems from past experiences where the government has stopped some modernization efforts after industry invested in supporting technologies. For example, FAA developed a datalink communications system that transmitted scripted e-mail-like messages between controllers and pilots. One airline invested in this technology by equipping some of its aircraft, but because of funding cuts, among other things, FAA canceled the program. We have also reported that some aviation stakeholders have expressed concern that FAA may not follow through with its airspace redesign efforts and are hesitant to invest in equipment unless they are sure that FAA will remain committed to its efforts.²⁰ One expert suggested that the government might mitigate this issue by making an initial investment in a specific technology before requesting that airlines or other industry stakeholders purchase equipment.

Stakeholders' belief that the government is fully committed to NGATS will be important as efforts to implement NGATS technologies move forward. Achieving many of the benefits of NGATS will require actions by FAA as well as by users of the system—airlines and general aviation. For example, JPDO has identified ADS-B as a new air traffic surveillance system that will be critical to NGATS. ADS-B would replace many existing radars that track aircraft location and speed with less costly ground-based

²⁰GAO, *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).

transceivers. FAA views ADS-B as a cornerstone technology for NGATS that will increase NAS capacity, efficiency, and safety. However, to achieve the full benefits of ADS-B, FAA must develop policies and regulations and install the ground infrastructure to support ADS-B, while users of the system must install ADS-B-compatible equipment on their aircraft.

FAA has developed plans for implementing ADS-B over the next 15 to 20 years. FAA plans to award a contract for acquiring the ground infrastructure for ADS-B in July 2007 and is developing an ADS-B rulemaking, scheduled for issuance in 2009. FAA's initial deployment plans focus on areas of the nation that do not have radar surveillance, such as the Gulf of Mexico. During this initial deployment, FAA plans to further develop ADS-B interfaces with its existing ATC systems. According to FAA, the agency is also working with national and international organizations to ensure that the concerns of the aviation community are recognized and addressed. FAA plans to deploy ADS-B nationwide by 2013.

However, full utilization of ADS-B depends not only on government efforts, but also involves decisions by nonfederal stakeholders about what equipment to purchase and the timing of such purchases. With ADS-B for example, an official of RTCA's ADS-B working group noted that the cost and expected benefits of equipping aircraft to take full advantage of ADS-B is a key issue for users of the system.²¹ On the cost side, the expert said that equipping existing aircraft to communicate with the ground stations may not be cost prohibitive for regional and large commercial airlines, but equipping these aircraft to be able to utilize ADS-B's full capabilities could require cost prohibitive modifications. Consequently, the expert noted that carriers plan to install equipment to utilize ADS-B's full capabilities only as they order new aircraft. He also said that carriers could have full-capability ADS-B installed on new aircraft that they are ordering now, except that specifications do not yet exist. Concerning the benefits of equipping aircraft to fully utilize ADS-B, the expert noted that the extent of

²¹Organized in 1935 and once called the Radio Technical Commission for Aeronautics, RTCA is today known just by its acronym. RTCA is a private, not-for-profit corporation that develops consensus-based performance standards for ATC systems. RTCA serves as a federal advisory committee, and its recommendations are the basis for a number of FAA's policy, program, and regulatory decisions. RTCA includes an ADS-B working group within its air traffic management advisory committee. The ADS-B Working Group includes representatives of air transport, avionics manufacturers, business aviation, Department of Defense, and general aviation.

some of these benefits are dependent on FAA decisions that have not yet been made, such as whether FAA will grant responsibility to pilots for maintaining safe separation distances and what technologies will provide a backup system for ADS-B. The expert believed that some air carriers were hesitant on ADS-B due to concerns that FAA might not follow through with deployment of full ADS-B capabilities.

Credibility of JPDO's efforts could also be impacted by perceptions regarding the progress of NGATS planning efforts. For example, some members of our expert panel told us that, although JPDO has produced much activity, they did not feel the effort had demonstrated sufficient progress. Some stakeholders we spoke with felt the Integrated Plan and Progress Report have not contained detailed implementation plans or interim milestones. According to one stakeholder, JPDO's 2005 Progress Report lacked information related to the evolution of an implementation plan, definition of research needs, and some discussion of relative costs and funding for NGATS, or a definitive plan to produce these vital pieces of information. While JPDO officials recognize that some stakeholders have been critical of JPDO's progress to date, these officials believe that given JPDO's mission—to involve partner agencies and nonfederal stakeholders—progress will happen at a more measured pace.

Our own technical expert in enterprise architecture examined JPDO's draft Concept of Operations and determined that it does not yet include key elements such as scenarios illustrating NGATS operations; a summary of NGATS' operational impact on users and other stakeholders; and an analysis of the benefits, alternatives, and trade-offs that were considered for NGATS.²² According to our technical expert, the draft Concept of Operations lacks an overall description that ties together the five areas—air navigation service operations, flight operations, network centric infrastructure services, shared situational awareness services, and security management services—that the draft document covers. Our expert believes that the five areas are currently disjointed and that the document only provides some details for one area—the air navigation service operations. As noted earlier, JPDO officials are currently incorporating stakeholder comments into the draft Concept of Operations and will release another version.

²²Our senior level technologist reviewed JPDO's Concept of Operations for the Next Generation Air Transportation System, version 0.2, dated July 24, 2006, by comparing it with the IEEE Standard 1362-1998 for concept of operations documents.

JPDO Recognizes the Importance of Global Harmonization, but Challenges Remain

Vision 100 calls for harmonization activities and some progress has been made in facilitating harmonization, although challenges remain in creating modernized systems that are globally interoperable. FAA and the European Commission signed an MOU in July 2006 to ensure coordination between the aviation modernization programs in Europe and the United States. According to the MOU, FAA and the European Commission intend to explore and discuss opportunities for implementing common or interoperable technologies and synchronizing time lines in the development of regulations, standards, procedures, research and development, and other activities to be agreed upon later. The MOU provides broadly for these activities to be accomplished through information exchanges, coordination of studies, and participation in working groups and consultative bodies. JPDO is currently working with the European Commission to plan regular technical interchange meetings to conduct peer reviews of NGATS and SESAR developments. Two of these meetings are tentatively planned for fiscal year 2007, according to JPDO officials.

JPDO's Global Harmonization IPT (led by FAA) is planning cooperative activities and has made some progress, although the IPT is still early in its planning activity. The Global Harmonization IPT, whose mission is to harmonize equipment and operations globally and to advocate the adoption of U.S.-preferred transformation concepts, technologies, procedures, and standards, is led by managers from ATO's Operations Planning Services International and FAA's Office of International Aviation. The IPT finalized its charter in March 2006 and is working to develop an international strategy and outreach plan. As part of this effort, JPDO and FAA officials have met with officials from various parts of the world—including Europe, Canada, China, Japan, and Mexico—to assess the potential for cooperative NGATS demonstrations. JPDO officials noted that there are working visits and ongoing negotiations with China and Japan on MOUs, and ADS-B activities in Australia and East Africa. Internally, the Global Harmonization IPT also plans to raise awareness of harmonization issues within the other IPTs as they consider performance requirements for NGATS.

FAA Faces Several Challenges to Its Ability to Successfully Implement NGATS

Institutionalizing ATO's recent improvements in management and acquisition processes will be critical to the successful implementation of NGATS. FAA will be challenged to fund operation of the current air traffic control system while simultaneously funding the implementation of and transition to NGATS technologies and systems. FAA will also be challenged to obtain the expertise needed to implement a system as complex as NGATS.

Institutionalizing Recent Improvements in Management and Acquisition Processes Will Be Critical to the Successful Implementation of NGATS

As the primary entity responsible for implementing NGATS, FAA will need to ensure that the management reforms it has recently instituted continue. Since 1995, we have designated FAA's ATC modernization program as high risk because of systemic management and acquisition problems. Realization of NGATS's goals could be severely compromised if these problems carry over into FAA's implementation of NGATS, which is an even more complex and ambitious undertaking than past ATC modernization efforts.

FAA has recently taken a number of actions aimed at improving its management practices. FAA hired a Chief Operating Officer in 2003 and established the performance-based ATO in early 2004 to operate and modernize the air traffic control system. Since the establishment of ATO, the Chief Operating Officer has been focusing on implementing more businesslike management and acquisition processes to address the cost, schedule, and performance shortfalls that have plagued ATC modernization over the years. Under the new structure, FAA is a flatter organization, with fewer management layers, and managers are in closer contact with the services they deliver. FAA has also taken some steps to break down the vertical lines of authority, or organizational stovepipes, that we found hindered communication and coordination across FAA. To increase accountability, FAA has established a cost accounting system and made the units that deliver services within each department responsible for managing their own costs. In addition, managers are evaluated and rewarded according to how well they hold their costs within established targets.²³

Finally, FAA is revising its acquisition processes, as we recommended,²⁴ and is taking steps to improve oversight, operational efficiency, and cost control. To ensure executive-level oversight of all key decisions, FAA has revised its Acquisition Management System to incorporate key decision points in a knowledge-based product development process. Moreover, as we have reported,²⁵ an executive council now reviews major acquisitions

²³Our work has shown that it is important, when implementing organizational transformations, to use a performance management system to assure accountability for change. See [GAO-03-669](#).

²⁴GAO, *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).

²⁵[GAO-05-23](#).

before they are sent to FAA's Joint Resources Council.²⁶ To better manage cost growth, this executive council also reviews breaches of 5 percent or more in a project's cost, schedule, or performance. FAA has also issued guidelines for disclosing the levels of uncertainty and imprecision that are inherent in cost estimates for major ATC systems and has begun to base funding decisions for system acquisitions on a system's expected contribution to controlling operating costs.

To its credit, FAA has taken steps to institutionalize these improvements—that is, provide for their duration beyond the current administration at FAA and ATO by ensuring that the reforms are fully integrated into the agency's structure and processes at all levels and have become part of its organizational culture. FAA's strategic plan, titled "Flight Plan 2006–2010," contains a strategy to implement corporate systems, policies, programs, and tools to build a results-oriented, high-performance workforce. FAA's Human Capital Plan includes a goal to create a results-oriented culture and strategies for implementing performance management and compensation systems that focus on achieving results.

FAA has also established a performance goal and begun tracking metrics for acquisitions. The goal for fiscal years 2004 and 2005 was to have 80 percent of its system acquisitions on schedule and within 10 percent of budget. The goal gradually increases to 90 percent by fiscal year 2008. The increase will make FAA's acquisition performance goal consistent with targets set in the Department of Transportation's strategic plan and will comply with the Federal Acquisition Streamlining Act of 1994.²⁷ To date, FAA reports that it has been meeting its performance goal.

Our past work identified FAA's lack of a constructive acquisition workforce culture as a key factor contributing to problems in its ATC modernization program. We view FAA's changes as important steps toward institutionalizing a results-oriented culture. Using a performance management system to define responsibility and ensure accountability for change is a key practice that can help agencies transform their cultures so

²⁶The 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 makes corporate-level decisions, including those that determine whether an acquisition meets a mission need and should proceed. The council also approves changes to a program's baseline, budget submissions, and the National Airspace System's architecture baseline.

²⁷Pub. L. No. 103-355.

that they can be more results oriented, customer focused, and collaborative. However, transforming organizational cultures requires substantial management attention. The experiences of successful transformations and change management initiatives in large public and private organizations suggest that it can take 5 to 7 years or more until such initiatives are fully implemented, and cultures are transformed in a sustainable manner.

Finding Resources to Implement NGATS and Operate the ATC System Poses a Challenge

The cost of operating and maintaining the current ATC system while implementing NGATS will be another important challenge in transitioning to NGATS—a system that, as noted, is broader in scope than the current ATC system and will require funding for security technologies and environmental activities, as well as ATC technologies. Finding opportunities to reduce costs or realize savings could mitigate this challenge. Implementing the new technologies envisioned in the operational concept for NGATS could provide opportunities for reducing costs. For example, NGATS envisions more use of satellites for surveillance and navigation, which could allow FAA to decommission some of its ground-based navigational aids, such as compass locators, outer markers, and nondirectional radio beacons. FAA also is working to reduce costs by consolidating its administrative activities, currently decentralized across its nine regions, into three regions, and anticipates an annual savings of up to \$460 million over the next 10 years.

Until FAA has completed its estimates of both NGATS costs and cost savings that it will be able to achieve between now and 2025, it will not be able to determine how far these cost savings will go toward financing NGATS. Nonetheless, one expert has preliminarily estimated that FAA's current expected savings through infrastructure and operational efficiencies will be well below the amount needed to support NGATS capital funding.²⁸ While more information is needed to estimate the amount of any shortfall with greater confidence, even the preliminary estimate signals the extent of the resource challenge.

²⁸Aviation Management Associates, Inc., *The "No New Money" Scenario for the Next Generation Air Transportation System* (Alexandria, VA: Oct. 1, 2005).

FAA Faces Challenges in Obtaining the Expertise Needed to Implement a System as Complex as NGATS

A lack of expertise contributed to weaknesses in FAA's past management of ATC modernization projects. Although the personnel flexibilities that Congress authorized in 1995 allowed FAA to establish criteria for outstanding performance and match industry pay scales for needed expertise, industry experts continue to question whether FAA will have the technical expertise needed to implement NGATS—a task of unprecedented complexity, according to JPDO, FAA, and other aviation experts. A panel of experts that we convened in 2004 to discuss FAA's ATC modernization program noted that a shortfall in technical expertise was the key technical factor affecting modernization.²⁹ The panelists said that FAA sometimes lacked the technical proficiency to “scrub” project proposals early on for potential problems and to oversee the contractors who implemented its modernization projects.

The need for expertise also extends to the tasks of contract administration. According to a 2005 study by the Merit Systems Protection Board,³⁰ at least 50 percent of the government's contracting officer representatives—the government's technical experts who are responsible for developing and managing the technical aspects of contracts—reported needing training in areas such as contract law, developing requirements, requesting bids, developing bid selection criteria and price determinations, and monitoring contractor performance.

Recognizing the complexity of the NGATS implementation effort and the possibility that FAA may not have the in-house expertise to manage it without assistance, we have identified potential approaches for supplementing FAA's capabilities. One of these approaches is for FAA to contract with a lead systems integrator (LSI). Generally, an LSI is a prime contractor that would help to ensure that the discrete systems used in NGATS will operate together and whose responsibilities may include designing system solutions, developing requirements, and selecting major system and subsystem contractors. The government has used LSIs before for programs that require the integration of multiple complex systems. Our research indicates that, although LSIs have certain advantages, such as the knowledge, understanding, skills, and ability to integrate functions across

²⁹GAO, *National Airspace System: Experts' Views on Improving the U.S. Air Traffic Control Modernization Program*, [GAO-05-333SP](#) (Washington, D.C.: April 2005).

³⁰U.S. Merit Systems Protection Board, *Contracting Officer Representatives: Managing the Government's Technical Experts to Achieve Positive Contract Outcomes* (Washington, D.C.: December 2005).

various systems, their use also entails certain risks. For example, because an LSI may have significantly more responsibility than a prime contractor usually does, careful oversight is necessary to ensure that the government's interests are protected and that conflicts of interest are avoided. Consequently, selecting, assigning responsibilities to, and managing an LSI could pose significant challenges for JPDO and FAA.

Another approach that we have identified involves obtaining technical advice from federally funded research and development corporations to help the agency oversee and manage prime contractors. These nonprofit corporations are chartered to provide long-term technical advice to government agencies in accordance with various statutory and regulatory rules to ensure independence and prevent conflicts of interest. FAA officials indicated that they are considering these two approaches to help address any possible gaps the agency may have in its technical expertise. However, FAA has not yet formally explored its strengths and weaknesses with regard to the technical expertise and contract management expertise that will be required of it to define, implement, and integrate the numerous complex programs and systems inherent in the transition to NGATS.

Conclusions

Transforming the National Airspace System to accommodate what could be three times the current demand for air transportation services by 2025, providing appropriate security and environmental safeguards, and doing these things seamlessly while the current system continues to operate will be an enormously complex undertaking. As JPDO notes in its Integrated Plan, there has never been a transformation effort similar to this one with as many stakeholders and as broad a scope. As JPDO nears the end of its third year of operation, it has done a significant amount of work to create an organizational structure that facilitates the federal interagency collaboration and stakeholder participation that must occur for the office to be successful in its mission. JPDO has made significant strides in meeting its planning and coordination role as set forth by Congress.

However, there are some practices important to institutionalizing the collaborative process that JPDO has not yet established. These practices could improve the office's chances for long-term success. Clearly defining roles and responsibilities of all the parties at all the organizational levels is fundamental to such a large and complex collaborative effort. To date, JPDO has established its basic organizational structure but has not yet refined the roles and responsibilities within those structures. Particularly important will be the ability of JPDO and ATO to define their roles and responsibilities and form a collaborative environment for planning and

implementing the next generation system. Also important to JPDO's success are establishing mechanisms for dispute resolution, leveraging resources, and ensuring the involvement of all crucial stakeholders in the planning for NGATS. While JPDO has incorporated numerous stakeholders from industry, academia, and state and local governments into the IPTs, current air traffic controllers represent one important group of stakeholders who are not participating at this time.

Other areas important to NGATS need to evolve further. JPDO has begun the process of developing cost estimates with the series of workshops that it is holding, and these workshops should be very helpful to JPDO in obtaining crucial stakeholder input on cost issues. However, much work remains before any type of reliable and comprehensive estimates for NGATS costs can be expected. Without cost information, Congress is handicapped in its efforts to plan accordingly for NGATS. It will be important, as the enterprise architecture takes shape, that JPDO expedite its efforts to provide Congress with credible cost estimates that include costs for all of the JPDO partner agencies, as well as costs related to training, technology development, and demonstration projects.

Another important area is ensuring global harmonization on systems and procedures so that international travel and commerce are not harmed by incompatible modernization efforts. The establishment of JPDO's Global Harmonization IPT and the recent signing of the MOU between FAA and the European Commission should begin to address the many issues involved with harmonization, but it is not yet clear what specifically will be done to further international cooperation. Finally, as noted, the complexity of the effort to transform the nation's air transportation system is staggering. FAA will be challenged to have in place the technical and contracting expertise needed to manage the transition to NGATS.

Recommendations for Executive Action

Because of the importance of the successful planning and implementation of NGATS and the need for effective collaboration between diverse organizations, we are recommending that the Secretary of Transportation direct JPDO to take the following five actions:

- To better institutionalize its practices and expectations for interagency collaboration and stakeholder involvement, JPDO should finalize and present to the Senior Policy Committee for its consideration and action the MOU among the partner agencies to define their roles and responsibilities related to NGATS planning and development.

-
- Clarify the roles and responsibilities between JPDO and ATO in the planning, development, and transition from JPDO to FAA for implementation of NGATS.
 - Develop written procedures that formalize agreements with OMB regarding the leveraging of partner agency resources and the identification of NGATS-related programs within agency budgets.
 - Develop written procedures for dispute resolution at all levels of the JPDO organization.
 - To better ensure the involvement of all key stakeholders in the NGATS planning process, determine whether key stakeholders and expertise are not represented on JPDO's integrated product teams, divisions, or elsewhere within its organization. For example, JPDO should consider the addition of active, subject matter expert air traffic controllers to its integrated product teams.

We are recommending that the Secretary of Transportation direct FAA to take the following action:

- Given the technical complexity of the implementation of NGATS and FAA's past experiences, undertake a formal exploration of FAA's 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 and systems inherent in the transition to NGATS. For example, FAA should work to determine whether it will need to contract with an LSI, federally-funded not-for-profit corporation, or other technical or managerial entity to assist in the implementation of NGATS.

Agency Comments and Our Evaluation

We provided a draft of this report to the Departments of Commerce, Defense, Homeland Security, and Transportation; FAA; JPDO; NASA; and the White House Office of Science and Technology Policy for their review and comment. NASA provided written comments, which are reprinted in appendix IV. Transportation, FAA, JPDO, Homeland Security, and the Office of Science and Technology Policy provided technical clarifications and additional information, which we incorporated into this report as appropriate. FAA and JPDO neither agreed nor disagreed with our recommendations, but said they would consider them. Commerce and Defense had no comments on the draft report.

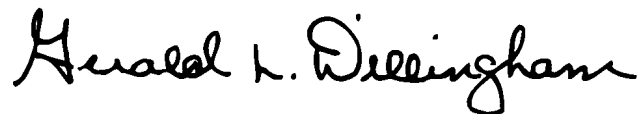
NASA generally agreed with the report's contents, but highlighted three items that the agency felt were important. First, NASA believes that its return to fundamental aeronautics research will be critical to the success of NGATS and is uniquely suited to NASA's core expertise. NASA stated that until the enterprise architecture, operational improvement road maps, and integrated capability work plans are developed, any assertion of a technology development gap is highly speculative and cannot be factually substantiated. As our report points out, NASA plans, to its credit, to address the research and development needs of NGATS. However, as our report also points out, numerous experts and stakeholders with whom we spoke believed that NASA's move toward fundamental research does create a technology development gap and that it is unclear at this time what entity will do the developmental work for NGATS technologies prior to transitioning these technologies to an acquisition program. Our work has shown that developing technology to higher levels of maturity help avoid cost, schedule, and performance problems later, as systems are acquired. For example, we have reported that cost overruns, schedule delays, and performance shortfalls occurred in the Department of Defense's weapons acquisitions, in part because the technologies were transitioned to acquisitions before they were fully developed. Second, NASA noted that, while it leads the Agile Air Traffic System IPT, implementation of the system will be the responsibility of FAA. We agree and do not intend to suggest in our report that an agency's leadership of an IPT implies that an agency is necessarily responsible for implementation of related systems. We modified the text accordingly. Finally, NASA notes that the fiscal year 2007 President's Budget Request and run out for NASA aeronautics research projects a relatively flat, not declining, funding profile. However, as we have noted in a recent report, when converted into 2005 dollars, NASA's proposed aeronautics research budget will decrease by nearly 30 percent from \$906 million in 2005 to \$647 million (in 2005 dollars) in 2011.³¹

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to interested congressional committees and the members of the JPDO Senior Policy Committee, JPDO Board, and the JPDO Executive Director. We also will

³¹ [GAO-06-920](#).

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 concerning this report, please contact me on 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. Key contributors to this report are listed in appendix V.

A handwritten signature in black ink that reads "Gerald L. Dillingham". The signature is written in a cursive style with a large initial "G".

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

Appendix I: Scope and Methodology

We examined (1) the status of the Joint Planning and Development Office's (JPDO) efforts to plan for the Next Generation Air Transportation System (NGATS), (2) the key challenges facing JPDO as it moves forward with its planning efforts, and (3) the key challenges facing the Federal Aviation Administration (FAA) as it implements the transformation while continuing its current operations.

To determine the status of JPDO's efforts to plan for NGATS and the challenges that the office faces, we discussed JPDO's plans and products with the office's Director, Deputy Director, division heads, and the leaders of each JPDO integrated product team (IPT). We reviewed relevant literature and JPDO publications, including JPDO's December 2004 Integrated Plan, 2005 Progress Report, and draft NGATS Concept of Operations. We reviewed previous GAO reports on the National Airspace System, air traffic control modernization, and federal interagency collaboration. We reviewed the National Academy of Sciences' 2005 report on JPDO entitled "Technology Pathways: Assessing the Integrated Plan for a Next Generation Air Transportation System." We assessed the status and challenges of JPDO's framework for facilitating coordination among its partner agencies by comparing JPDO's efforts to date against selected key practices that we have reported can enhance and sustain federal collaborative efforts.¹ We selected five of eight practices as criteria for this review because they are significant to building the framework needed for any collaboration and are particularly important to JPDO at this early juncture in its collaborative efforts. The key practices used for this assessment include defining and articulating a common outcome, establishing mutually reinforcing or joint strategies, identifying and addressing needs by leveraging resources, agreeing on roles and responsibilities, and reinforcing agency accountability for collaborative efforts through agency plans and reports.² We assessed JPDO's efforts to obtain the participation of nonfederal stakeholders by obtaining the perspectives of nonfederal stakeholders involved with JPDO and drawing on our body of work on stakeholder involvement. We assessed JPDO's technical planning efforts for NGATS by comparing JPDO's practices with those that we have found to be effective in developing enterprise

¹GAO-06-15.

²The remaining three practices include establishing compatible policies, procedures, and other means to operate across agency boundaries; developing mechanisms to monitor, evaluate, and report on results; and reinforcing individual accountability for collaborative efforts through performance management systems.

architectures.³ We also obtained the perspectives of nonfederal stakeholders whose organizations are represented on the Institute Management Council of the NGATS Institute, and interviewed nonfederal stakeholders who represent the aviation industry on various IPTs. We met with FAA's Chief Architect to discuss how FAA's enterprise architecture for the National Airspace System would be integrated into that for NGATS, as well as cost estimates for NGATS. We also discussed NGATS cost estimates with a member of FAA's Research, Development and Engineering Advisory Committee (REDAC) and obtained information on REDAC's estimate of future FAA costs under NGATS. We did not review in detail the methodology or assumptions that REDAC used to develop this estimate. Additionally, we observed two NGATS Investment Analysis Workshops—one held with commercial and business aviation stakeholders and one held with general aviation stakeholders. One of our senior level technologists from our Applied Research and Methods team, who has been involved in our past work on enterprise architectures and has contributed to our federal guide on enterprise architecture, reviewed JPDO's draft Concept of Operations by comparing it with the Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standard 1362-1998 for concept of operations documents.⁴ We also conducted a one-day panel of aviation experts during which we sought their perspectives on the status of JPDO's planning efforts and the challenges that it faces in planning for NGATS. For more detailed information on the expert panel, see appendix II.

Because international harmonization is a key element of NGATS and the European Union has embarked on a concurrent venture known as the Single European Sky Air Traffic Management Research Programme (SESAR), we obtained information on the plans for SESAR and discussed harmonization issues with officials in France, Belgium, and the Netherlands.

To determine the challenges that FAA faces in implementing NGATS, we met with the agency's Chief Operating Officer to discuss how FAA would

³An enterprise architecture is a tool, or blueprint, for understanding and planning complex systems. JPDO anticipates that the NGATS enterprise architecture will provide the means for coordinating among the partner agencies and private sector manufacturers, aligning relevant research and development activities, and integrating equipment. See [GAO-05-266](#).

⁴IEEE is a nonprofit, technical professional association that develops standards for a broad range of global industries, including the information technology and information assurance industries and is a leading source for defining best practices.

integrate the many expected components of NGATS into FAA's modernization plans. We also discussed FAA's implementation plans for System Wide Information Management and Automatic Dependent Surveillance-Broadcast, two key elements of NGATS, with these programs' respective program management officials and drew upon our work examining FAA's program to modernize the National Airspace System.

We conducted our work between July 2005 and September 2006 in accordance with generally accepted government auditing standards.

Appendix II: Results of Expert Panel Voting

We contracted with the National Academy of Sciences to convene a panel of experts and stakeholders. Our panel was held on March 2, 2006, at the National Academy of Sciences in Washington, D.C. The panel consisted of 14 experts from the aviation industry and academia, one of whom served as the panel's moderator. (See table 2.) We worked with the National Academy of Sciences to identify and select panelists who were knowledgeable about the efforts of the Joint Planning and Development Office (JPDO) and could respond to our questions about JPDO's achievements and challenges. The panelists were asked to provide their views during several sessions held during the day.

Table 2: Names and Affiliations of Expert Panelists

Name	Affiliation
Ronald R. Fogleman (moderator)	Principal, Durango Aerospace, Inc.; Chief of Staff, U.S. Air Force (<i>retired</i>)
Langhorne Bond	President, International Loran Association; Federal Aviation Administration (FAA) Administrator (<i>retired</i>)
Carol Carmody	Director of Transportation Initiatives, The National Academy of Public Administration
Jerald M. Davis	President, Foxfire Inc.; FAA (<i>retired</i>)
Soeren Fischer	Vice President Strategy & Communication, Air Traffic Alliance
Mark Hansen	Professor, Department of Civil and Environmental Engineering, University of California-Berkeley
John B. Hayhurst	Senior Vice President, The Boeing Company (<i>retired</i>)
Richard E. Heinrich	Director, Strategic Initiatives, Commercial Systems, Rockwell Collins, Inc.
Bill Jeffers	Senior Director, FAA Programs, ARINC; FAA (<i>retired</i>)
Richard Marchi	Senior Advisor, Airports Council International-North America
Amy R. Pritchett	David S. Lewis Associate Professor of Cognitive Engineering, School of Aerospace Engineering, Georgia Institute of Technology
Dorothy Robyn	The Brattle Group, Inc.
William F. Wangerien	Vice President, Operations, Planning, and Reliability Control, Delta Airlines, Inc. (<i>retired</i>)
Christopher Wickens	Professor Emeritus, University of Illinois at Urbana-Champaign

Sources: GAO and National Academy of Sciences.

Following a welcome and introductions, the panel moved into the four sessions, as follows:

- *Session One: Overview of JPDO.* In this session, the Chief Operating Officer of FAA and the Acting Deputy Director of JPDO each gave a presentation and answered questions from the panelists. The Chief Operating Officer discussed the challenges of running a complex air traffic organization. The Acting Deputy of JPDO explained how the office is

organized to attract public and private sector expertise. These officials departed prior to the second session.

- *Session Two: Identifying JPDO's Achievements and Challenges.* The panelists were asked to identify what they considered to be JPDO's major achievements of the past 2 years and why. Following that discussion, they were asked to identify the major challenges ahead for JPDO and how those challenges might hinder JPDO's ability to move forward with planning and developing the next generation air transportation system (NGATS).
- *Session Three: Strategies for Addressing JPDO's Challenges.* The panelists were asked to identify strategies that JPDO could use to address the challenges identified in session two.
- *Session Four: Global Harmonization and Cooperation.* Panelists were asked to discuss how the different accountability and authority mechanisms of the JPDO and Single European Sky Air Traffic Management Research Programme (SESAR) could affect the success of each effort. They were also asked to what extent harmonization is important and why. Finally, they were asked what lessons were learned from other collaborative efforts between nations or cabinet-level departments.

At the end of the last three sessions, panelists were asked to respond to questions that summarized the issues discussed. For example, at the end of the second session, panelists were asked to select what they considered to be the top achievements from the full list of the achievements that they generated during the discussion.¹ For another session, panelists were asked about their level of concern on issues related to the level of coordination between Europe and the United States. In an attempt to provide context for the achievements and challenges as well as the other voting results, we examined the transcript to obtain statements in support of the most widely held views for each question. The views expressed by the panelists were their own and do not necessarily represent the views of GAO or the National Academy of Sciences.

¹Panelists voted electronically at the end of the last three sessions using voting equipment provided by GAO.

Session Two: Identifying JPDO’s Achievements and Challenges

During the second session, panelists discussed what they considered to be JPDO’s major achievements over the past 2 years. At the end of the discussion, the panelists generated a list of what they considered to be JPDO’s most significant achievements, in no particular order. To differentiate the relative significance of the achievements, each panelist was asked, in a series of three questions, to vote for the achievement he or she believed was the first, second, and third most significant. To produce a rank order of items on the list, achievements identified as the first most significant were assigned three points, the second most significant achievements were assigned two points, and the third most significant were assigned one point. The weighted values for each achievement were summed and then ordered from the achievements with the highest number of points to the lowest. (See table 3.)

Table 3: Expert Panel Votes on Top Achievements of JPDO

Expert panel votes—achievements	Rank
Established process (IPTs, NGATS Institute)	1
Senior-level interest	2
Established products (plans, organization)	3
Provided vision	4
Agency coordination, common dialogue	5
Began efforts to integrate budgets	6
Jump start: looking backward for continuity	7
Involvement of private sector	8

Source: GAO.

Note: When weighted rankings resulted in a tie, the tie was broken by determining which category had the highest number of votes in the first round, and, if necessary, the second round.

Panelists identified JPDO’s top achievement as establishing a process for conducting work related to the planning of NGATS. This included setting up the integrated product teams (IPT) and the NGATS Institute. One panel member said that JPDO had established a process. Another panelist stated that JPDO had taken “a significant step forward” by developing a process that brought people from different groups together in the same room to talk about building the aviation system of the future. Another panelist credited JPDO with establishing the NGATS Institute.

Panelists felt that senior-level interest was the second most significant achievement. For example, JPDO’s Senior Policy Committee includes cabinet-level representation. During the discussion, one panelist said he

believed that the level of interest shown by people within different cabinet departments and other agencies was good.

Finally, panelists identified the development of products, including plans and organizational structures, as the third most significant achievement. For example, one panelist said that having JPDO produce a product (i.e., the Integrated Plan) that Congress asked for, and delivering it on time, was a major achievement. Another panelist felt that JPDO provided continuity when it decided to incorporate Automatic Dependent Surveillance-Broadcast (ADS-B) and System Wide Information Management (SWIM) into its future plans. Too often, the panelist said, plans do not take into account past research and lessons learned.

During the second session, panelists also identified what they thought were the top three challenges facing JPDO. To produce a list of challenges, we followed the same general procedure used to identify JPDO’s major achievements as described above. That is, the panelists were asked a series of three questions and the answers were weighted to generate a single ranking. (See table 4.)

Table 4: Expert Panel Votes on Top Challenges Facing JPDO

Expert panel votes—challenges	Rank
Credibility (roadmap, detailed plan)	1
Lack of national priority	2
Collaborate with rest of the world	3
Lack of comprehensive plan	4
Responsibility without authority	5
Clarify relationship of JPDO/ATO ^a	6
Tension between mission and politics	7
Enterprise architecture accomplishments	8
Impact of annual budget process	(Tie) 9
Unclear mandate	(Tie) 9

Source: GAO.

^aATO is FAA’s Air Traffic Organization.

Note: When weighted rankings resulted in a tie, the tie was broken by determining which category had the highest number of votes in the first round, and, if necessary, the second round.

Panelists identified establishing credibility as the top challenge facing JPDO, due to FAA’s past track record in air traffic control modernization, the lack of detail in the Integrated Plan, and a lack of air traffic controller

and/or union involvement. For example, one panelist noted that early investors in previous modernization attempts did not always get the payback from their investment in new technology because of a lack of follow-through on programs that would use that technology. Some panelists were worried that the NGATS effort will simply be another failed effort at modernization. Second, some panelists felt that the Integrated Plan's lack of meaningful details directly impinged on JPDO's credibility. For example, one cited the National Research Council's evaluation of the Integrated Plan and said the plan was more "an aspirational vision than an integrated plan."² A second panelist said the only thing new in the JPDO vision was that it contained some information about security. Another said, "We're not convinced they're looking at the personnel issues, the aircraft issues, the economic issues, [or] the way to motivate people." Third, panelists also cited a lack of air traffic controllers' or union involvement in JPDO's process as a problem. Controllers have to be brought on board as equal partners or JPDO's efforts are "not going to work," said one panelist.

Panelists cited the second biggest challenge facing JPDO as the fact that NGATS is not viewed as a national priority; the panelists devoted a considerable amount of discussion to this topic. One panelist stated that "changing the airspace" needs to be made a presidential priority in order to get enough interest to align budgets and resources and to execute the program. In the words of another panelist, "...until there is some clear national priority given to this whole idea of the next generation airspace or plan or concept...it's going to be a series of band-aids and stops and starts."

The need to collaborate with the rest of the world was considered the third most significant challenge facing JPDO because the office will have to work with both the International Civil Aviation Organization (ICAO) and SESAR, the panelists said.³ Collaboration is necessary to harmonize as many aviation procedures as possible, panelists said. One panelist noted that because of ICAO's international role, it was really crucial that JPDO,

²National Research Council of National Academies *Technology Pathways: Assessing the Integrated Plan for a Next Generation Air Transportation System* (Washington, D.C.: 2005).

³ICAO was established in 1944 by 52 nations whose aim was to assure the safe, orderly and economic development of international air transport. ICAO serves as the global forum for civil aviation.

FAA’s ATO, and FAA keep ICAO informed. For example, the panelist said, “talk to them, brief them, collaborate with them, so that when there is a solution or a decision made about how to go forward, that it’s not sprung on the rest of the world, but the rest of the world has some awareness of how we got there.”

Session Three: Strategies for Addressing JPDO’s Challenges

In the third session, panelists were asked to discuss strategies that they felt JPDO could use to address the challenges that the panelists had identified in session two. At the end of the discussion, panelists generated a list of what they considered to be the most significant strategies, in no particular order. Panelists were asked in a series of questions to identify which strategies, in their opinion, should be implemented within the next 1-2 years, the next 3-5 years, and beyond 5 years. The results for each question below were ranked by the number of votes. (See tables 5-7.)

Table 5: Short-term Strategies for JPDO

What strategy is critical for JPDO to implement in the short term (within the next 1-2 years)?	Number of votes
Outsource the development of the plan	5
Appoint, support, and sustain strong leadership	4
Restructure the plan (stakeholder, requirements, metrics) and gap analysis	3
Presidential directive	1
Formalize collaborative structure with SESAR	1
Define stakeholders (European model, other analyses)	0
Better explain the economic consequences of doing nothing	0
Senior Policy Committee to clarify JPDO-ATO relationship and address legislative responsibilities	0
Total	14

Source: GAO.

Five of the 14 panelists identified outsourcing the development of the NGATS plan as critical to JPDO’s efforts in the short term (i.e., the next 1 to 2 years). According to the panelists, outsourcing to a contractor or group of contractors would have several benefits, including a more businesslike approach, more rapid completion of the planning, and more opportunity for a range of aviation companies to be involved (including some companies from other countries). One panelist felt that JPDO’s bureaucracy and political constraints impaired its ability to develop the business and technical plan needed for the future. Another panelist

believed that without outsourcing, JPDO may not succeed, something that could delay development of the system by three to five years. “And this is not a time that we can afford that,” the panelist said.

The second critical short-term strategy for JPDO, according to the panelists, is appointing, supporting, and sustaining strong leadership. Panelists said they were concerned about the turnover in leadership at JPDO. One panelist stated, “They haven’t had sustained, strong leadership,” noting JPDO had had three directors, while another negatively remarked about JPDO’s “revolving door structure.” One panelist also noted that, unlike Europe, the United States has no highly placed public official who acts as an advocate for the plan. In Europe, for example, the Vice President of the European Commission spent time advocating in addition to her regular duties. The panelist said that the leadership of this official is one of the single biggest differences that explain where the United States is versus where the European Union is today.

The third short-term strategy that panelists believed was critical to JPDO is restructuring the parts of the plan that relate to stakeholders, requirements and metrics, and performing a gap analysis. JPDO “ought to at least look at the European model as a place to start defining stakeholders,” one panelist said. Panelists also urged that the NGATS plan be restructured to incorporate metrics. The plan, one panelist said, is a large design problem that should be approached by figuring out what the metrics are, as well as the core issues and requirements. The plan should describe work being done and provide a clear statement of the metrics that should be achieved by 2025, as well as the interim milestones. Panelists additionally stated that a “gap” plan should be developed to identify areas that might fall between the ATO’s and JPDO’s efforts. The gap plan would need to be comprehensive, understandable, and explain who will do what and when it will be mandated.

Table 6: Midterm Strategies for JPDO

What strategy is critical for the JPDO to implement in the midterm (within the next 3-5 years)?	Number of votes
Restructure the plan (stakeholder, requirements, metrics) and gap analysis	3
Outsource the development of the plan	3
Formalize collaborative structure with SESAR	3
Appoint, support, and sustain strong leadership	2
Better explain the economic consequences of doing nothing	2
Presidential directive	1
Define stakeholders (European model, other analyses)	0
Senior Policy Committee to clarify JPDO-ATO relationship and address legislative responsibilities	0
Total	14

Source: GAO.

Panelists again identified restructuring the plan and conducting a gap analysis, as well as outsourcing the development of the plan, as two of the key midterm (3-5 years) strategies for JPDO. The panelists also identified establishing a structure that formalizes collaboration with SESAR as a third midterm strategy. One panelist said that JPDO should work with ICAO to come up with a structural framework for a full exchange between JPDO and SESAR—one that extends beyond the exchange of a few experts.⁴ Collaboration is important not only between JPDO and SESAR but also for the companies involved, the panelist said. For example, because Boeing and Rockwell Collins are working with SESAR, they contribute their views about technology, which will then become incorporated to ensure interoperability. In addition, panelists noted the importance of a collaborative structure is to help define a common set of performance requirements, especially for the airlines. “They want one set of procedures to be able to fly from A to B. And this is not only Europe, but worldwide,” one panelist said.

⁴It should be noted that on July 18, 2006, a Memorandum of Understanding (MOU) was signed between FAA and the European Commission. This MOU establishes a framework for cooperation between the FAA and the European Commission.

Table 7: Long-term Strategies for JPDO

What strategy is critical for the JPDO to implement in the long term (more than 5 years)?	Number of votes
Formalize collaborative structure with SESAR	5
Restructure the plan (stakeholder, requirements, metrics) and gap analysis	3
Appoint, support, and sustain strong leadership	2
Outsource the development of the plan	2
Better explain the economic consequences of doing nothing	1
Presidential directive	1
Define stakeholders (European model, other analyses)	0
Senior Policy Committee to clarify JPDO-ATO relationship and address legislative responsibilities	0
Total	14

Source: GAO.

Panelists identified the four most important long-term (more than 5 years) strategies for JPDO as (1) formalizing a collaborative structure with SESAR; (2) restructuring the plan; (3) appointing, supporting, and sustaining strong leadership; and (4) outsourcing the development of the plan, as discussed above.

Session Four: Global Harmonization and Cooperation

The fourth session focused on global harmonization and cooperation. Panelists were asked to discuss how the different accountability and authority mechanisms of JPDO and SESAR could affect the success of each effort. They were also asked to what extent harmonization is important and why. Finally, they were asked what lessons were learned from other collaborative efforts between nations or other cabinet-level departments. The panelists were then asked to vote on the questions below. In this case, the possible answers were generated by GAO prior to the expert panel. (See table 8.)

Table 8: Importance of JPDO Involvement in Harmonization Efforts

JPDO's involvement in global harmonization efforts is an essential component for the success of NGATS. Do you:	Number of votes
Strongly agree	10
Agree	2
Strongly disagree	0
Neither agree nor disagree	0
Disagree	2
Don't know	0
Total	14

Source: GAO.

Panelists overwhelmingly agreed that JPDO's involvement in global harmonization is essential for the success of NGATS. Panelists said that involvement in global harmonization efforts results in information sharing that benefits all member countries, largely through ICAO. One panelist noted that ICAO has a fairly good track record in helping member states reach agreement on harmonized standards. Panelists also noted that such collaborative efforts can result in sharing of best practices, as well as a working relationship with the European Union's SESAR effort. For example, one item for collaboration between JPDO and SESAR is resolving time frames for completion. JPDO has 2025 deadline, while SESAR's is 2020. "Gaps in things like that could be closed with cooperation and collaboration," one panelist said.

Table 9: Level of Coordination between Europe and the United States

Regarding the current level of coordination between Europe and the United States, we should be:	Number of votes
Very greatly concerned	7
Greatly concerned	4
Moderately concerned	1
Somewhat concerned	1
Not concerned	1
Total	14

Source: GAO.

Most panelists said that they were very greatly concerned, or greatly concerned, about the current level of coordination between the United States and Europe regarding global harmonization. (See table 9.) One

panelist stated that the existing concept of operations was developed with considerable coordination with other countries and thought that JPDO’s credibility would be harmed if it unilaterally developed a concept of operations. Another panelist added that the United States had worked closely with Europe to develop Advanced Technologies and Oceanic Procedures, which helps increase international travel capacity. In less than 10 years, this project went from an idea to a system that a number of people and countries supported, the panelist said. That achievement was done with very close coordination among the FAA, the U.S. aviation industry, and the European authorities and experts, the panelist said.

Table 10: Preparation for Success

Which initiative is better organized for success?	Number of votes
Europe	12
Too early to tell	2
United States	0
Don't know	0
Total	14

Source: GAO.

Panelists overwhelmingly said Europe’s SESAR initiative was better organized than JPDO for success. (See table 10.) They cited several reasons, including SESAR’s public-private partnership that focuses on letting industry develop the European plan. They also raised concerns that there was a lack of leadership with the U.S. effort, that there had been much activity but little progress, and that the sheer size of JPDO’s bureaucracy would hinder progress. In discussing the area of public-private partnerships, one panelist noted that SESAR’s organization was industry-centric, as opposed to the U.S. effort, which involves a service provider or political-centric activity. One panelist stated that “[W]e have two different models. I think one is headed toward success and one is going to be fraught with the problems of the past. So a solution-oriented answer is a more deeply focused industry set of implementations as opposed to an advisory role.” Another panelist expressed concern that FAA has a tendency to pick a project de jour and that project is now JPDO. Noting JPDO’s complex organizational chart, the panelist said, “[It] is nothing compared to the complexity that’s been built into the processes down at the IPT level.” The panelist said that people are being asked to make very large commitments of time to participate in multiple subgroups on each of eight IPTs, plus the NGATS institute. “I’m just concerned that

there's an awful lot of process here and not much substance," said the panelist.

Appendix III: SESAR: The European Air Traffic Modernization Initiative

The Single European Sky Air Traffic Management Research Programme (SESAR) is in some ways the European equivalent of next generation air transportation system (NGATS). While both initiatives are designed to increase the capacity of their respective air traffic management systems to meet expected increases in demand, SESAR is also intended to address Europe's historically fragmented airspace. Europe's patchwork of national systems has led to inefficiencies, capacity constraints, and delays. European countries have individually developed their air traffic management systems, but this uncoordinated development risks duplication of effort, significant additional cost, and unnecessary delays in the introduction of new equipment. The European Organisation for the Safety of Air Navigation (Eurocontrol), ATM 2000+ Strategy, and other initiatives had attempted to address these issues by obtaining collaboration among the numerous stakeholders. However, these efforts did not always include all stakeholders, and progress was impeded because consensus could not be reached. Hence, the delays continue and problems are expected to worsen with the expectation of at least a doubling of demand by 2020.

To more forcefully address these issues, the European Parliament and member states agreed on regulations that were entered into force in April 2004 creating a "Single European Sky." In contrast to past efforts by Eurocontrol, the Single European Sky legislation provides more authority to unify and harmonize air traffic management equipment and procedures throughout Europe and establishes various mechanisms to help ensure the participation of stakeholders. To carry out the Single European Sky vision, the European Commission and Eurocontrol created the SESAR project, which is divided in two major phases: definition and implementation, and is expected to last until 2020.

The definition phase of SESAR started in March 2006 and will last 2 years. Planning done under the definition phase is being handled by a 29-member SESAR Consortium that includes airlines, air navigation service providers, airports, and suppliers. The SESAR Consortium is performing the planning under a contractual arrangement with Eurocontrol that calls for specific time lines and deliverables. The SESAR Consortium has formed a 10-member executive committee to make decisions on deliverables, to make other key decisions, and resolve disputes. To ensure that the future users of the new system—the airlines—have a major say in the outcome of the definition phase, four of the executive committee members are representatives of airlines. The remainder of the committee is composed of three members representing air navigation service providers, two members representing airports, and one member representing suppliers.

The day-to-day management of the definition phase is run by the Air Traffic Alliance—a consortium of Airbus, EADS, and Thales—following a call for tender for a project manager by Eurocontrol. The Air Traffic Alliance answered the call and won the contract, which calls for the delivery of a Master Plan that will lay out a mission for the future Single European Sky and a roadmap for implementation. The European Commission and Eurocontrol have provided 60 million euros (\$76 million) to fund the project definition phase with half provided by each organization.¹

The SESAR Consortium is a bottom-up organization, meaning that the aviation industry is essentially developing the ATM roadmap for final approval by Eurocontrol and the European Commission. The definition phase has been organized into six sequential deliverables and 20 work packages. A mixture of consortium members will work on each package, to ensure the appropriate use of expertise and consideration of viewpoints. For example, airlines, air navigation service providers, suppliers, and Eurocontrol, will work on the Master Plan. The first deliverable, a report describing the current air transport situation, identifying critical issues, and recommending ways to address these issues was published in July 2006.²

In addition to the SESAR members, several associations are project associates, such as the International Air Transport Association, which represents commercial airlines, and the European Cockpit Association, which represents pilots. Project associates, including U.S. companies Boeing, Rockwell Collins, and Honeywell, are also involved in this phase of the project.

The second phase of SESAR—implementation (2007-2013)—will focus on systems design and producing the key systems components. The commission has proposed using a joint undertaking to implement the Single European Sky. A joint undertaking is a legal entity that permits a mixture of public and private funding and was also used to implement Europe's Galileo satellite navigation system. The plan for the joint undertaking, however, has not yet been finalized under the European

¹To convert euros to U.S. dollars, we used 1.26855, the foreign exchange rate for September 19, 2006, as published in *The Washington Post*.

²SESAR Consortium, *Air Transport Framework: The Current Situation*, DLM-0602-001-03-00 (July 2006).

Union's procedures. Tentative plans to fund the development phase (2008-2013) call for \$381 million annually.³ One-third of the funding would come from the commission, one-third from Eurocontrol, and one-third from industry.

³To convert euros to U.S. dollars, we used 1.26855, the foreign exchange rate for September 19, 2006, as published in *The Washington Post*.

Appendix IV: Comments from the National Aeronautics and Space Administration

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001



October 31, 2006

Reply to Attn of: Aeronautics Research Mission Directorate

Dr. Gerald L. Dillingham
Director, Physical Infrastructure Issues
United States Government Accountability Office
Washington, DC 20548

Dear Dr. Dillingham:

NASA appreciates the opportunity to comment on the draft of the Government Accountability Office (GAO) Report GAO-07-25 entitled "Next Generation Air Transportation System: Progress and Challenges Associated with the Transformation of the National Airspace System." While we agree with the majority of the content, we would like to highlight three items that we think are important.

First, there are several references to NASA's return to fundamental aeronautical research creating a potential gap in technology development. NASA would like to point out that the return to cutting-edge fundamental aeronautics research focuses our attention on research that is considered high risk by industry because the payoff from an economic standpoint is typically uncertain as well as long-term, and the results are not appropriable to a single company. Such research will be critical for the success of the Next Generation Air Transportation System (NGATS) and is uniquely suited to NASA's core expertise. Ultimately, however, as the report of the Commission on the Future of the U.S. Aerospace Industry (2002) stated: "*Industry has the responsibility for leveraging government and university research and for transforming it into new products and services, quickly and affordably.*" Our return to fundamental, innovative research will increase the probability of developing the revolutionary technologies that will be required for the successful implementation of NGATS and will broaden the advanced technology development options.

Regarding this first point, NASA would like to further emphasize that identification of a potential gap in technology development is highly speculative until the Enterprise Architecture, the Operational Improvement roadmaps, and the Integrated Capability Work Plans are developed and agreed upon by the Joint Planning and Development Office members. These activities are planned to occur during FY 2007. Until then, assertions of gaps cannot be factually substantiated.

Second, while NASA is the Integrated Product Team (IPT) lead for the Agile Air Traffic System (ATS), we will not be responsible for its establishment. NASA leads the Agile ATS IPT because it has primary responsibility for conducting the necessary research; implementation of the Agile ATS will be the responsibility of the Federal Aviation Administration.

Third, we would like to indicate that the FY 2007 President's Budget Request and run out for NASA aeronautics research projects a relatively flat, not declining, funding profile.

In closing, NASA would again like to thank you for the opportunity to provide comments about the GAO draft report. We hope that these comments will be useful.

Sincerely,



Lisa J. Porter
Associate Administrator for
Aeronautics Research Mission Directorate

Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the individual named above, key contributors to this report were Nabajyoti Barkakati, Jay Cherlow, Kevin Egan, Colin Fallon, Brandon Haller, David Hooper, Heather Krause, Elizabeth Marchak, Edmond Menoche, Faye Morrison, Taylor Reeves, Richard Scott, and Sarah Veale.

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