JOINT PLANNING AND DEVELOPMENT OFFICE: ACTIONS NEEDED TO REDUCE RISKS WITH THE NEXT GENERATION AIR TRANSPORTATION SYSTEM

Federal Aviation Administration

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Memorandum

U.S. Department of Transportation
Office of the Secretary
of Transportation
Office of Inspector General

Subject: ACTION: Joint Planning and Development Office: Actions Needed To Reduce Risks With the Next Generation Air Transportation System Federal Aviation Administration Report Number AV-2007-031

Date: February 12, 2007

From: David A. Dobbs
Principal Assistant Inspector General
for Auditing and Evaluation

Reply to Attn. of: JA-10

To: FAA Administrator

This report presents the results of our review of the Federal Aviation Administration's (FAA) Joint Planning and Development Office (JPDO). The purposes of the JPDO are to manage work related to the Next Generation Air Transportation System (NGATS), coordinate Federal research efforts, and create a plan to transition from FAA's existing National Airspace System into the next generation system.

At the request of the Chairman and Ranking Member of the House Aviation Subcommittee, we examined progress to date with the JPDO. As agreed with the requestors, our objectives were (1) assessing the JPDO's progress to date in aligning diverse agency budgets and (2) determining actions that will help the JPDO move from planning to implementation. Also, the Chairman of the House Science Committee requested that we keep his office apprised of the results of our work on the JPDO.

We have testified on progress to date with the JPDO before the House and Senate on several occasions and outlined actions needed to transition from planning to implementation.[1] This report summarizes our results and formally transmits our recommendations for improving coordination and reducing risk with the next

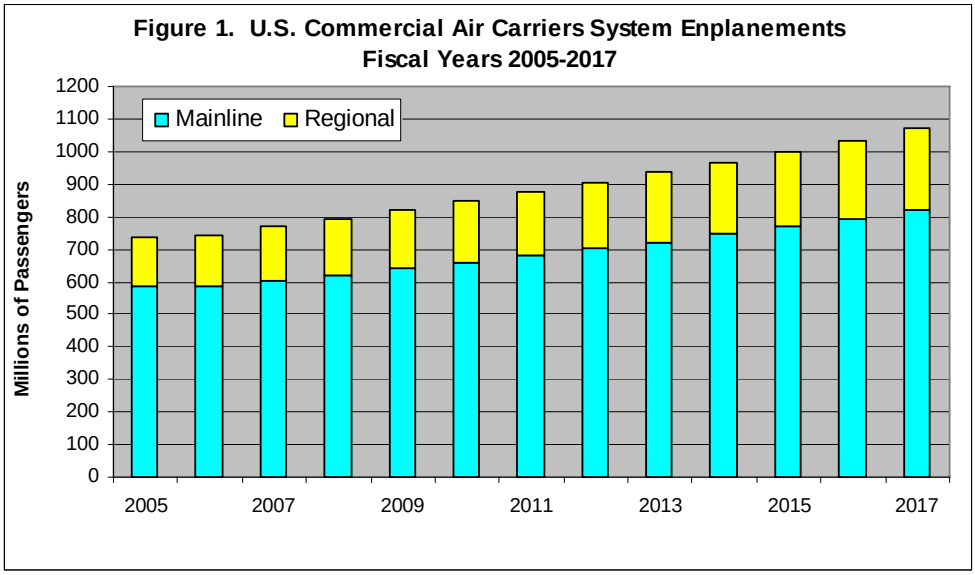
[1] OIG Testimony CC-2006-032, "Observations on the Progress and Actions Needed To Address the Next Generation Air Transportation System," March 29, 2006; OIG Testimony CC-2006-031, "Observations on Current and Future Efforts To Modernize the National Airspace System," June 21, 2006; OIG Testimony CC-2006-065, "Perspectives on the Progress and Actions Needed To Address the Next Generation Air Transportation System," July 25, 2006. OIG reports and testimonies can be found on our website: www.oig.dot.gov.

generation system—one of the most technologically complex undertakings FAA has embarked upon in years. Exhibits A through E provide details on: (A) research efforts needed for NGATS; (B) potential agency contributions for specific missions; (C) NGATS Integrated Product Teams; (D) key modernization platforms that will aid in moving forward with NGATS; and (E) our report objectives, scope, and methodology.

BACKGROUND

The JPDO was mandated by Congress in Vision 100—Century of Aviation Reauthorization Act[2]—to develop a vision for NGATS in the 2025 timeframe and coordinate diverse agency research efforts. This office was established within FAA to coordinate research efforts underway at the National Aeronautics and Space Administration (NASA), Department of Commerce, Department of Defense (DOD), and Department of Homeland Security (DHS).

There are a number of compelling reasons for moving toward NGATS. The current air transportation system has served the Nation well, but FAA reports that the current system (or business as usual) will not be sufficient to meet the anticipated demand for air travel or changes in the industry. Last year, over 700 million passengers used the system, and this number is forecasted to grow to over 1 billion by 2015. Figure 1 illustrates the expected increases in passenger traffic for both mainline and regional airlines.



Source: FAA Forecast 2005 - 2017

[2] Public Law No. 108-176 (2003).

As the JPDO points out in various planning documents, NGATS is more than just increasing capacity; enhancements are also envisioned in the areas of security, safety, and impact reduction for aircraft noise and emissions. For example, DHS and the JPDO are working to develop new security measures for the National Airspace System as well as new screening technology to mitigate potential threats to the air transportation system.

RESULTS IN BRIEF

The JPDO has established ambitious, much needed goals to create a system that will handle three times more air traffic and reduce FAA operating costs. The JPDO also expects a shift from FAA's current ground-based automation system to an aircraft-based, net-centric[3] system that will significantly enhance controller productivity through automation.

We found that the JPDO's congressionally mandated mission to leverage resources at other agencies is critical given that FAA conducts little long-term air traffic management research and the fact that most of the Agency's current $2.5 billion capital account goes toward keeping things running (i.e., sustainment). Moreover, only about 55 percent of FAA's capital account goes toward acquiring air traffic control systems, the remaining funds go to personnel, mission support, and facilities. We have identified a number of issues that will enhance coordination between JPDO participants and reduce risk with developing and transitioning to the next generation system.

Progress Is Being Made in Coordinating Diverse Research Initiatives but Not in Alignment of Agency Plans and Budgets to Date

Central to the JPDO's mission is the alignment of ongoing research at other Federal agencies. This is a complex task because each agency conducts it own research and development efforts to support its individual missions. To coordinate these interagency efforts, the JPDO has established eight Integrated Product Teams (IPT) with representatives from FAA, participating agencies, and the private sector. While there are significant opportunities to leverage ongoing research, there is also considerable potential for duplication of effort.

We reviewed three of these IPTs—weather, shared situational awareness, and air traffic management—and found that there was considerable coordination but little or no alignment of research and development (R&D) budgets and plans. Further,

[3] An airborne system that will use internet protocols to transfer data over an airborne/ground data network in which each aircraft will function as a node that will receive and pass on common information to other aircraft and the ground.

individual IPT team leaders have no authority to commit their parent agency's resources. The difficult part of adjusting and redirecting various agencies' research efforts to meet NGATS requirements lies ahead over the next year. FAA is taking important steps in working with the Office of Management and Budget (OMB) to develop an integrated budget document for the JPDO as well as a list of specific programs at other agencies that support the development of NGATS.

NASA's Role in NGATS Is Critical and Will Require More Attention

NASA's role in this coordination and leveraging will require sustained management attention and focus. This is important because NASA is expected to develop a wide range of capacity, safety, and environmental research to support NGATS. This includes, among other things, developing concepts and elements of new automation systems to help enhance capacity, boost controller productivity, system throughput (the number of aircraft that use the system during a period of time), and shift greater responsibility to the cockpit.

Range of Actions To Reduce Risk With NGATS and Shift From Planning to Implementation

- Establish cost estimates, quantify expected benefits, and develop a roadmap for industry.
- Develop and implement mechanisms for alignment between agencies.
- Develop approaches for risk management and systems integration.
- Conduct sufficient human factors research to support anticipated changes for controllers and pilots.

Historically, NASA has funded and managed the majority of long-term air traffic management research, including the development for prototypes that were pilot-tested at FAA air traffic control facilities. In the mid 1990s, for example, NASA developed new automated controller tools for sequencing aircraft for arrival that were part of the successful Free Flight Phase 1 program.

However, NASA is rethinking its overall aeronautics research portfolio and is spending less. Senior NASA officials have told us that NASA no longer plans to develop prototypes as it has in the past and that research would be restricted to "fundamental research."[4] There are concerns that NASA's restructuring efforts will create gaps in both funding and technology readiness that will affect milestones for NGATS. The extent of these gaps and impact on NGATS milestones will not become clear until the JPDO has developed a more definitive

[4] NASA officials define "fundamental research" as continued long-term, scientific study in areas such as physics, chemistry, materials, experimental techniques, and computational techniques that lead to a furthering of understanding of underlying principles that form the foundation of the core aeronautics disciplines as well as research that integrates the knowledge gained in these core areas to significantly enhance capabilities, tools, and technologies at the disciplinary (e.g., aerodynamics, combustion, and trajectory prediction uncertainty) and multidisciplinary (e.g., airframe design, engine design, and airspace modeling and simulation) levels.

concept of operations and a mature enterprise architecture—or technical blueprint—for NGATS.

FAA and NASA need to reach agreement on what will be expected from NASA to support NGATS initiatives. Given the important role that NASA is expected to play, Congress and aviation stakeholders need to know sooner rather than later if FAA will have to assume a larger than expected role to complete development of NGATS initiatives. As a contingency, FAA should begin assessing alternatives and develop plans for how this research and development will be conducted, managed, and paid for.

Actions Needed To Reduce Risk With Transitioning to NGATS

Moving to NGATS is important to meet the demand for air travel, change the way FAA provides services, and help control operating costs. However, it is also an extraordinarily complex and high-risk effort given the potential multibillion-dollar investments by FAA and airspace users. Also, the transition to NGATS will involve important policy questions, such as how to spur aircraft equipage and how to handle a mix of aircraft with different capabilities in congested airspace. We have identified a range of actions that will help FAA and the JPDO transition from planning to implementation.

Finalizing Cost Estimates, Quantifying Expected Benefits, and Developing a Roadmap for Industry

The JPDO's March 2006 progress report[5] to Congress was silent on funding requirements and complex transition issues. Moving to NGATS will require significant investments from FAA (new ground systems) and airspace users (new avionics).

We have reviewed some preliminary estimates developed by the Air Traffic Organization (ATO) and the working group from FAA's Research, Engineering and Development Advisory Committee (REDAC), but those estimates have not been finalized or approved by senior FAA management. There are considerable unknowns, and costs depend on such factors as performance requirements for new automation, weather initiatives, and the extent to which FAA intends to consolidate facilities.

An important theme from JPDO workshops, conducted with the aviation industry to help develop cost estimates, is the need for FAA to clearly define the *expected benefits* from NGATS initiatives, particularly for projects that require airspace

[5] NGATS Report, "2005 Progress Report to the Next Generation Integrated Plan," March 2006.

users to install new avionics. At the April 2006 workshop, industry participants asked FAA for a "service roadmap" that (1) specifies required equipage in specific time increments, (2) bundles capabilities with clearly defined benefits and needed investments, and (3) uses a 4-to 5-year equipage cycle that is coordinated with aircraft maintenance schedules. This service roadmap does not yet exist. It will be important for FAA to provide industry with this information.

We are recommending that the JPDO develop and report the costs of NGATS to Congress and stakeholders along three vectors—development efforts, adjustments to existing programs, and NGATS implementation. This will give decision makers a clearer understanding of NGATS costs and their dimensions.

Developing and Implementing Mechanisms for Alignment Between Agencies To Help Develop NGATS as Mandated by Law

There is considerable ongoing coordination among JPDO participating agencies but little alignment of budgets and plans. JPDO progress reports do not provide specific details on participating agencies' research projects that the JPDO expects to leverage. As we reported in congressional testimonies, the JPDO needs mechanisms to help it align diverse agency efforts over the long term. The JPDO recognizes this and is working with OMB to, among other things, develop an integrated budget document.

We are recommending that the JPDO include in its periodic reports to Congress a table of specific research projects with budget data for both FAA developmental efforts and other agencies it is leveraging and report on how that ongoing research is supporting the JPDO. This will help decision makers address whether FAA is leveraging the right research and taking full advantage of ongoing research being performed by other agencies.

Developing Approaches for Risk Management and Systems Integration

The transition to NGATS is a high-risk effort for both the Government and industry potentially involving billions of dollars, and the JPDO and FAA need to articulate how problems that affected past modernization efforts will be mitigated and what specific skill sets will be required. This is important because the transition to NGATS will require synchronized investments over several years between FAA (new ground systems) and airspace users (new avionics).

FAA is planning a number of demonstration projects for various NGATS initiatives, which represent important opportunities to reduce risk. Given past problems with certifying new systems as safe and the importance of policies and procedures, we are recommending that demonstration projects (1) establish a path

for certifying new systems and (2) identify changes to policies and procedures that will be needed to get benefits.

Conducting Sufficient Human Factors Research To Support Anticipated Changes

The JPDO is planning to make fundamental changes in how the system operates (for both controllers and pilots) so it can accommodate three times more aircraft in the system. Our work shows that focused human factors work will be needed to ensure that expected changes in roles and responsibilities of pilots and controllers can safely be accommodated. Key issues include what can reasonably be expected from new automation systems and how more responsibility can be shifted to the cockpit. We are recommending that the JPDO conduct sufficient human factors analyses and studies to ensure that the changes envisioned for NGATS can be safely accomplished.

SUMMARY OF RECOMMENDATIONS

Our recommendations focus on actions FAA and the JPDO need to take to establish cost estimates, quantify benefits, align research between agencies, develop a service roadmap, reduce risk with next generation initiatives, and to speed the introduction of new capabilities into the National Airspace System. A complete set of our recommendations begin on page 17.

SUMMARY OF AGENCY COMMENTS AND OFFICE OF INSPECTOR GENERAL RESPONSE

On December 15, 2006, we provided FAA with a draft copy of this report. On February 9, 2007, FAA gave us its formal response, which is included in its entirety in the Appendix. In its response, FAA fully concurred with all but one of our recommendations.

FAA partially concurred with our recommendation to use technology readiness levels in assessing the technical maturity of research and development projects received from partner Agencies. FAA points out that the use of technology readiness levels alone does not facilitate successful technology transfer. We agree and point out in our report that successful transition of technology also requires close cooperation between researchers and users of existing systems. The planned actions that FAA highlights in its response, such as further developing the concept of operations and the NGATS R&D plan and using FAA's Operational Evolution Plan to track technology maturity, are responsive to the intent of our

recommendation. Therefore, we consider FAA's planned actions responsive to all nine of our recommendations, subject to follow-up requirements in Department of Transportation Order 8000.1C.

We appreciate the courtesies and cooperation of FAA representatives during this audit. If you have any questions concerning this report, please call Robin Hunt, Acting Assistant Inspector General for Aviation and Special Program Audits, at (415) 744-0420 or Matt Hampton, Program Director, at (202) 366-1987.

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cc: FAA Deputy Administrator
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FINDINGS

The JPDO was mandated by Congress to develop a vision for NGATS in the 2025 timeframe and coordinate diverse agency research efforts. This office was established within FAA; also participating are NASA and the Departments of Commerce, Defense, and Homeland Security. The successful implementation of NGATS will involve coordinated efforts by all participating agencies. Because of the need to enhance capacity and the potential impact on FAA's budget and operations, our work thus far has focused primarily on the JPDO's air traffic management efforts that involve NASA, DOD, and Commerce.

There are a number of compelling reasons for moving toward NGATS. The current air transportation system has served the Nation well, but FAA reports that the current system (or business as usual) will not be sufficient to meet the anticipated demand for air travel. Last year, over 700 million passengers used the system, and this number is forecasted to grow to over 1 billion by 2015.

The JPDO's mission is critical given that FAA conducts little long-term air traffic management research and the fact the most of the Agency's current $2.5 billion capital account goes toward sustainment and day-to-day operations. However, the cost of NGATS remains uncertain and much work remains to refine costs; align diverse agency budgets; and set expectations for airspace users with respect to milestones, equipage, and anticipated benefits. We have identified a range of actions that the JPDO needs to address to transition from planning to implementation. These include the following:

- Finalize cost estimates, quantify expected benefits, and develop a roadmap for industry;
- Establish linkage between the plans developed by JPDO and the implementation priorities of the Air Traffic Organization by delineating lines of responsibility and accountability for both;
- Develop and implement mechanisms for aligning resources between agencies; and
- Develop approaches for risk management and systems integration.

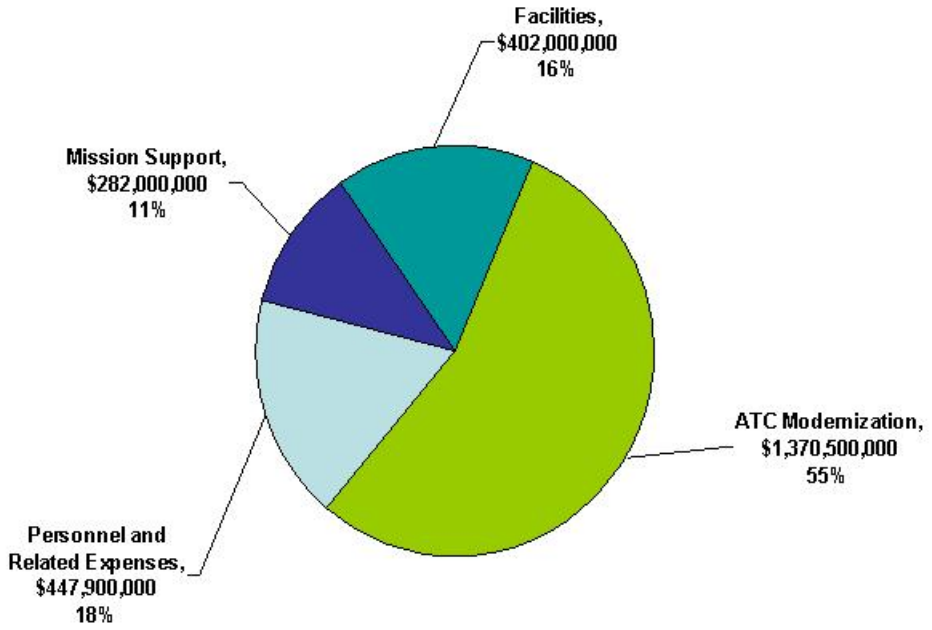
The JPDO's Mission Is Critical Because Most of FAA's Capital Investment Focuses on Sustainment, and FAA Conducts Little Air Traffic Management Research

FAA's capital account—or the Facilities and Equipment (F&E) account—is the principal vehicle for modernizing the National Airspace System. It represents about 18 percent of the Agency's fiscal year (FY) 2007 budget request of

$13.7 billion. For FY 2007, FAA is requesting $2.5 billion for the F&E account, which is $50 million less than last year's appropriation. This is the fourth consecutive year that funding requests for the capital account are below authorized levels called for in Vision 100. As we have noted in previous reports and testimonies, FAA's increasing operating costs have crowded out funds for modernization.

As illustrated in Figure 2, only about 55 percent of FAA's FY 2007 F&E request (or $1.4 billion) will actually go for acquiring air traffic control systems. The remainder will be spent on personnel, mission support, and facilities.

Figure 2. FAA's FY 2007 Facilities and Equipment Budget Request



Source: FAA's FY 2007 Budget Request

As we have noted in previous testimonies, the majority of FAA's capital account now goes for keeping things running (i.e., sustainment), not new initiatives. A review of the top 10 projects by dollar amount in the FY 2007 budget request shows that while some projects will form the platforms for future initiatives, the bulk of funds are requested for projects that have been delayed for years and for efforts to improve or maintain FAA facilities or replace existing radars.

Over the last several years, FAA has deferred or cancelled a number of projects as funding for the capital account has remained essentially flat. This includes efforts

for a new air-to-ground communication system, controller-pilot data link communications, and a new satellite-based precision landing system. FAA has also postponed making decisions on projects like the billion-dollar Standard Terminal Automation Replacement System.

Even though FAA lacks clarity about NGATS, it is requesting F&E funds for two projects that are considered "building blocks" for the next generation system. These are not new programs and have been under development or been funded in previous budgets.

- Automatic Dependent Surveillance-Broadcast (ADS-B)[6] is a satellite-based technology that allows aircraft to broadcast their position to others. FAA is requesting $80 million in FY 2007 for this satellite-based technology. In prior budgets, ADS-B was funded under the *Safe Flight 21 Initiative*, which demonstrated the potential of ADS-B and cockpit displays in Alaska and the Ohio River Valley.

  FAA expects to award a service contract for the ADS-B ground infrastructure in 2007. However, a number of challenges must be addressed: conducting human factors work and determining how air and ground elements will be certified as safe. FAA may have to rely on a rulemaking initiative to help speed equipage. This illustrates why the JPDO must address complex policy issues as well as research as it moves forward with NGATS initiatives.

- System Wide Information Management (SWIM) is a new information architecture that will allow airspace users to access securely and seamlessly a wide range of information on the status of the National Airspace System and weather conditions. It is analogous to an internet system for all airspace users. FAA is requesting $24 million for this program in FY 2007, which is scheduled to be reviewed by the Joint Resources Council in the spring of 2007.

[6] The first phase of ADS-B implementation, known as *ADS-B out*, is expected to replace many ground radars that currently provide aircraft surveillance with less costly ground-based transceivers. Aircraft would be equipped with ADS-B out, which broadcasts a signal to these transceivers. However, implementing ADS-B out is just the first step to achieving the larger benefits of ADS-B, which would be provided by *ADS-B in*. ADS-B in would allow aircraft to receive signals from ground-based transceivers or directly from other aircraft equipped with ADS-B. This could allow pilots to "see" nearby traffic and, consequently, transition some responsibility for maintaining safe separation from the air traffic controllers to the cockpit.

FAA Has Historically Relied on NASA for Long-Term Air Traffic Management Research

Historically, FAA's R&D efforts have focused on short-term research, with NASA conducting the majority of long-term air traffic management research, including automated controller tools and human factors work. NASA has requested $724 million for FY 2007 on aeronautical R&D. The JPDO is looking to NASA to develop automated aircraft metering and sequencing and dynamic airspace reconfiguration. Table 1 illustrates NASA investments in aeronautics research in FY 2005 and FY 2006 and the request for FY 2007.

Table 1. NASA Funding for Aeronautics Research (Dollars in Millions)

NASA Aeronautics Research	FY 2005 Operating Plan	FY 2006 Operating Plan	FY 2007 Budget Submission
Fundamental Aeronautics	630	571	447
Airspace Systems	149	174	120
Aviation Safety	183	148	102
Aeronautics Test Program	0	0	55
Total	**962**	**893**	**724**

Source: NASA FY 2007 Budget Request and FY 2006 September Operations Plan Update

Note: It is difficult to compare prior year aeronautics R&D budgets because the recent restructuring has changed the way individual programs are portrayed in budget requests and planning documents.

As shown above, NASA will be spending less on aeronautical research than it has in the past and is planning on restructuring its aeronautical research portfolio. In discussing progress with the JPDO, NASA's Associate Administrator for Aeronautics told us that NASA no longer plans to develop prototypes and that research would be restricted to "fundamental research." This is in sharp contrast to the support it gave FAA with the Free Flight Phase 1 program. Exhibit A outlines several examples of required research.

An April 2006 draft REDAC report[7] on financing the next generation air transportation system raised concerns about NASA's efforts to restructure its aeronautic program and its potential impact on NGATS. The draft report stated that NASA changes to its aeronautical research efforts will place uncertainty on the ability of NASA to deliver development efforts at the same level of

[7] Federal Aviation Administration Research, Engineering and Development Advisory Committee draft report, "Financing the Next Generation Air Transportation System," April 2006.

technological maturity that it has in the past. As a result, FAA would have to assume a larger burden and the associated costs to complete development and bring new systems to fruition.

Progress Is Being Made in Coordinating Diverse Agency Efforts but Considerable Work Remains

To align agency budgets and plans, Vision 100 requires the JPDO to coordinate and oversee research that could play a role in NGATS. Central to the JPDO's mission—and making it an effective multi-agency vehicle—is alignment of agency resources. This is a complex task, and the law does not give the JPDO authority to redirect agency resources. Exhibit B provides information on potential agency contributions to the JPDO and each agency's area of expertise.

JPDO's March 2006 progress report to Congress outlined various accomplishments to date, including the establishment of multi-agency teams and the NGATS institute (a mechanism for interfacing with the private sector). However, the report did not provide details on specific ongoing research projects at FAA or funding that the JPDO expects to leverage at other agencies. Without this information, it is difficult to assess the JPDO's progress with aligning budgets.

The majority of the JPDO's work is done through eight Integrated Product Teams (IPT) that focus on eight strategies, such as how to use weather information to improve the performance of the National Airspace System. The teams are composed of personnel from FAA, other Federal agencies, and the private sector. Exhibit C provides more information on the IPTs.

JPDO's Integrated Product Teams
(With the Lead Agency)

- Airports (FAA)
- Security (DHS)
- Air Traffic Management/Agile Air Traffic System (NASA)
- Shared Situational Awareness (DOD)
- Safety (FAA)
- Environmental (FAA)
- Weather (Commerce/National Oceanic Atmospheric Administration)
- Global Interoperability (FAA)

We believe that a more product-driven focus for IPTs would be an important step forward. In 2005, the National Research Council examined JPDO plans and was also critical of the IPT structure. The Council's report[8] found that even though the teams have multi-agency participation, they are functioning primarily as experts in specific disciplines rather than as cross-functional, integrated, multidisciplinary teams organized to deliver specific products. One of the report's recommendations was that the IPTs be reduced in number and made more "product driven."

[8] National Research Council, "Technology Pathways Accessing the Integrated Plan for a NGATS System," 2005.

Our work on three IPTs shows that there is considerable coordination but little alignment of agency budgets to date. Moreover, the IPT leaders have no authority to commit agency resources to JPDO efforts and often have no products other than plans. The following illustrates progress and challenges to date with the three IPTs we examined in detail.

The Weather IPT is led by the National Oceanic Atmospheric Administration (NOAA), an agency of the Department of Commerce. FAA, NASA, DOD, and NOAA are all conducting weather research tailored for their specific missions. Thus far, this team's efforts have focused on contributions to FAA's Traffic Flow Management Program (which helps traffic managers optimize air traffic by working with airlines). NOAA is also helping the JPDO refine its concept of a fully automated system. Integrating new, up-to-date weather forecast systems into planned automation efforts will be challenging.

As we noted in congressional testimony before the House and Senate, the JPDO had not determined whether or not a considerable amount of applied research and development conducted by NOAA at the Office of Atmospheric Research and the National Environmental Satellite, Data, and Information Service could be leveraged for NGATS initiatives.[9] We shared our concerns about taking full advantage of weather research conducted by others with the JPDO throughout our review. In commenting on our report, JPDO officials stated that the weather IPT has done a better job of identifying the research that needs to be done and the task now focuses on getting it aligned.

The Shared Situational Awareness IPT is led by DOD. All participating agencies are adopting network-centric systems.[10] As noted earlier, FAA is developing its own network system called SWIM. While there are considerable opportunities for leveraging net-centric efforts, there is also potential for duplication of effort. Challenges here focus on taking an approach pioneered by DOD and applying it specifically to air traffic control to enhance capacity and reduce delays.

An active role by DOD is vital because it is both a provider and a consumer of air traffic services. Thus far, work in this IPT has focused almost exclusively on maximizing agency network capabilities in DOD, such as the Global Information Grid, which is a net-centric communication system DOD is developing for global use. Moreover, DOD's real-world experiences and lessons it has learned in sharing data (from air and ground systems) in actual real-time operations have not been tapped and will prove invaluable in reducing cost and technical risks in developing NGATS.

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[9] For additional details, see OIG Testimony CC-2006-065, "Perspectives on the Progress and Actions Needed To Address the Next Generation Air Transportation System," July 25, 2006.

[10] A net-centric system uses internet protocols to transfer data over a network.

Another area where DOD could provide expertise is with *sensor fusion*[11]—integrating information on an aircraft's position from radar and non-radar sources, such as satellite-based systems. While fusion could help reduce separation between aircraft, it will be technically challenging to integrate radar and satellite-based systems (which have different update rates and levels of accuracy) to manage traffic in high-volume airspace, particularly in the vicinity of airports. DOD expertise with target acquisition and sensor fusion for weapons targeting could prove helpful for the JPDO.

The Air Traffic Management IPT is led by NASA. It is expected to play a key role by helping to develop the automated systems to boost controller productivity. The bulk of this work will be funded by NASA, which has conducted the majority of long-term air traffic management research over the last few years.[12] FAA has neither planned nor budgeted for this type of research. Major challenges focus on establishing requirements and gaining a full understanding of the risks associated with developing and acquiring these new software-intensive systems before making financial commitments. This is important because future automation efforts will be a major cost driver for NGATS.

JPDO and NASA are working on several complex concepts for new automation systems (e.g., for monitoring multiple aircraft trajectories, separation minima, and responding to weather events) and the timing of research efforts. This work will be funded through NASA efforts on "airspace systems" (with an FY 2007 requested funding level of $120 million). This effort will be a significant for "mid-to-long-term" development and implementation of automation platforms for "strategic 4D trajectory management," i.e., the monitoring and effective safety management of large numbers of aircraft with respect to time, longitude, latitude, and altitude.

While FAA and NASA need to reach agreement on how far NASA will develop cutting edge concepts, it is also true that NASA will need more details about FAA system requirements with respect to reliability, performance, and failure rates. Ultimately, FAA and the JPDO must effectively manage the transfer of technology from NASA, from the research stage, and to system development and full implementation.

[11] For additional views on "sensor fusion" or "fusion tracking," see OIG Report Number AV-2005-016, "Terminal Modernization: FAA Needs To Address Its Small, Medium, and Large Sites Based Upon Cost, Time, and Capability," November 23, 2004.

[12] For additional details on the FAA and NASA relationship and funding profiles, see OIG Testimony CC-2006-032, "Observations on the Progress and Actions Needed To Address the Next Generation Air Transportation System," March 29, 2006.

A Range of Actions Are Critical for the JPDO To Make Progress in Both the Short and Long Term and Make the Transition From Planning to Implementation

Key questions for FAA and the JPDO are what they can deliver, when it will be delivered, and how much the next generation system will cost. These questions are central in the discussion about how to best finance FAA and will shape the size, requirements, and direction of the capital program for the next decade.

Moving to NGATS is important to meet the demand for air travel, change the way FAA provides services, and help control operating costs. However, it is also a high-risk effort given the potential multibillion-dollar investment by FAA and airspace users. Since we testified in July 2006, FAA has taken some positive steps. For example, FAA named a new Director for the JPDO and released a draft concept of operations for NGATS (a vision for how controllers, pilots, and new systems will work together). We understand that the JPDO is planning to restructure its IPTs to better facilitate the development of concepts and technologies and better align NGATS partner agency efforts. Nevertheless, a number of issues that we raised over the last year remain to be addressed, and actions need to be taken.

Finalizing Cost Estimates, Quantifying Expected Benefits, and Developing a Roadmap for Industry

The JPDO's progress report to Congress was silent on funding requirements and complex transition issues. Moving to NGATS will require significant investments from FAA (new ground systems) and airspace users (new avionics). FAA is conducting workshops with industry to gather input on the potential costs of the future system.

We have seen some preliminary estimates developed by the Air Traffic Organization and a working group of FAA's REDAC, but they have not been finalized or approved by senior FAA management. These estimates indicate that an additional $500 million to $1 billion annually will be required between FY 2009 to FY 2012 to accommodate NGATS initiatives. However, there are still considerable unknowns, and costs will depend on, among other things, performance requirements for new automation, weather initiatives, and the extent to which FAA intends to consolidate facilities.

FAA will have to analyze information from the JPDO and industry workshops and the REDAC working group and provide Congress with expected funding requirements and the expected timeframe for when funding will be needed. When transmitting this information to Congress, FAA should provide cost data on three vectors—research and development needed (including demonstration projects),

adjustments to existing projects, and estimates for implementing NGATS initiatives. This will give decision makers a clear understanding of NGATS costs.

Key NGATS Cost Drivers

- Development of new systems and meeting FAA certification requirements
- Adjustments to existing modernization programs
- NGATS implementation
- Aircraft equipage

A key short-term cost factor for NGATS is the level of development funding that will be required to transition efforts from other agencies (e.g., NASA), successfully implement them in the National Airspace System, and meet FAA's safety and certification requirements. The REDAC working group is raising concerns about this in light of NASA's restructuring of its aeronautics research portfolio and plans to focus more on fundamental research. To accommodate changes in NASA investments, the REDAC working group estimated that approximately $100 million annually for development funding will be needed to address this technology gap.

The impact of changes in NASA's aeronautical research and development priorities will necessitate a better understanding of the level of technical maturity planned for the NASA research efforts developed for NGATS. FAA is working with its partner agencies, including NASA, on a memorandum of understanding to clarify roles and responsibilities with respect to NGATS. This is an important action that needs to be completed.

We believe that it will be important for FAA and NASA to come to a clear understanding of the level of technical maturity NASA projects will have. This has cost and schedule implications for NGATS, particularly new automated systems for controllers. If NASA is unable to provide projects at a level that FAA can transition to prototypes, the JPDO and FAA will have to determine how this R&D will be completed, managed, and paid for.

In addition, it is important to recognize that FAA's existing investments will heavily influence NGATS requirements and schedules. In fact, ongoing projects, like En Route Automation Modernization and FAA Telecommunications Infrastructure, will form important platforms for JPDO initiatives. Exhibit D provides details on selected modernization projects that will likely play a key role in moving toward NGATS. FAA will have to assess how JPDO plans affect ongoing projects and determine which ones need to be accelerated or re-scoped.

An important theme from the April 2006 JPDO cost workshop is the need for FAA to clearly define the *expected benefits* from NGATS initiatives, particularly for projects that require airspace users to install new avionics, such as ADS-B. As noted at the industry workshops, airspace users have a much shorter timeline for the return on investment from new systems than FAA, and incentives (e.g., tax

incentives, financing options, or targeted deployments for users that equip early) will likely be needed to spur equipage.

At the April 2006 workshop, industry participants asked FAA for a "service roadmap" that (1) specifies required equipage in specific time increments, (2) bundles capabilities with clearly defined benefits and needed investments, and (3) uses a 4-to 5-year equipage cycle that is coordinated with aircraft maintenance schedules. This service roadmap does not yet exist. It will be important for FAA to provide industry with this information.

Establishing Clear Lines of Responsibility and Accountability Between JPDO Plans and ATO Efforts To Better Facilitate the Introduction of New Capabilities Into the National Airspace System

Establishing effective and clear lines of responsibility and accountability is important because the JPDO, as currently structured, is a planning and coordinating organization—not an implementation or program-execution office. At the April 2006 workshop, industry groups also expressed the need for a much stronger linkage between JPDO and ATO programs.

Although the JPDO's progress report discusses new capabilities, such as ADS-B and SWIM, ATO is responsible for managing the efforts and establishing funding levels, schedule, and performance parameters. The ADS-B and SWIM projects are not yet integrated into ongoing communications and automation efforts but need to be. If the JPDO and ATO are not sufficiently linked and clear lines of accountability are not established, cost and schedules for NGATS will not be reliable and expected benefits will be diminished or postponed.

Linking JPDO and ATO efforts is challenging because NGATS projects cut across ATO's different lines of business (e.g., terminal and en route) and will require adjustments to ongoing projects managed by different ATO vice presidents.

For example, SWIM is envisioned as an FAA-wide effort, and planning documents show that SWIM will interface with at least 12 ongoing projects, including FTI which is managed by the Vice President for Technical Operations. Also, SWIM will need to be integrated with ongoing projects to revamp systems for controlling high-altitude traffic managed by the Vice President for En Route and Oceanic Services. Projects managed by the Vice President for Terminal Services (to modernize controller displays used in the vicinity of airports and weather systems) will also be affected. It will be important to establish clear lines of accountability for linking JPDO efforts to ATO programs and resolving differences between the two organizations. This is an important matter that will require sustained management attention.

Findings

We shared our concerns about effectively linking the JPDO and ATO and establishing clear lines of accountability with the Chief Operating Officer and the Acting Director for ATO Planning in the June 2006 timeframe. They recognize the need for close coordination and are examining ways to better link the two organizations. One step that is underway is to adjust the *Operational Evolution Plan* (the Agency's capacity blueprint) to reflect JPDO efforts.

Additionally, there have been discussions in the aviation community about the possible creation of a new ATO Vice President for Transformation. This position would be responsible for the success of the JPDO and FAA development of NGATS and would include responsibility for funded F&E programs that are determined to be enablers, such as SWIM and ADS-B.

Developing and Implementing Mechanisms for Alignment Between Agencies

As noted earlier, there is considerable coordination among JPDO participating agencies but little alignment of budgets or plans. There is a need for mechanisms to help the JPDO align diverse agency efforts over the long term.

The JPDO recognizes that more needs to be done and is working with OMB to develop an integrated budget document that provides a single business case (a document similar to the "OMB Exhibit 300") to make sure efforts are indeed aligned.[13] As part of this, the JPDO, in the FAA FY 2008 budget submission, provided OMB with an initial list of programs in other agency budgets that it intends to leverage.

NGATS Enterprise Architecture is a blueprint that links FAA's core programs and systems to the Agency's mission. This includes the transition from the "as-is" to the "to-be" environment.

The JPDO's ongoing efforts to develop the enterprise architecture, or overall blueprint for NGATS, will help in setting goals, supporting decisions, adjusting plans, and tracking agency commitments. The architecture will also show requirements from FAA and the Departments of Defense and Homeland Security and where various agency efforts fit in NGATS. It will prove helpful in the future in resolving difficult policy decisions, including who pays for what elements of the system.

The JPDO is taking an incremental approach to architecture development and plans to have a definitive version in calendar year 2007. However, considerable

[13] OMB Exhibit 300 was established by OMB as a source of information on which budgetary decisions could be based so that they are consistent with Administration and OMB policy and guidance.

work remains to link current systems with future capabilities and develop technical requirements, particularly for new concepts for automation.

Until these actions are taken, it will be difficult for the Congress and aviation stakeholders to determine if the JPDO is leveraging the right research, if funding is adequate for specific efforts, or how projects will improve the U.S. air transportation system and at what cost. Therefore, we are recommending that the JPDO include in its periodic reports to Congress a table of specific research projects with budget data for FAA developmental efforts and for other agencies it is leveraging and data showing how that ongoing research is supporting the JPDO.

Developing Approaches for Risk Management and Systems Integration

Key NGATS Risks

- Complex software development
- Systems integration
- Policy and procedure development
- Certification issues for air and ground systems
- Equipage issues for industry

Given that the transition to NGATS is a high-risk effort potentially involving billions of dollars, the JPDO and FAA need to articulate how problems that affected past modernization efforts will be mitigated and what specific skill sets will be required. Our prior audit work[14] on FAA's modernization efforts found billions of dollars in cost overruns and years of schedule delays that were traceable to overly ambitious plans, complex software development, changing requirements, and poor contract management. How these risks for NGATS initiatives will be managed was not addressed in the most recent progress report.

The central issue focuses on what will be done differently from past modernization efforts with NGATS initiatives (other than conducting demonstration projects) to ensure success and deliver much needed benefits to FAA and airspace users. While it is true that FAA has done a better job managing major acquisition programs in the past several years, developing and implementing NGATS will be an enormously complex undertaking. As the JPDO notes in its Integrated Plan,[15] there has never been a transformation effort similar to this one with as many stakeholders and as broad in scope.

FAA faces a wide range of risks; such as complex software development, complex systems integration, and engineering challenges; with NGATS initiatives (such as SWIM and ADS-B) and existing FAA projects. As previously noted, FAA also

[14] OIG Report Number AV-2005-061, "Status of FAA's Major Acquisitions: Cost Growth and Schedule Delays Continue To Stall Air Traffic Modernization," May 26, 2005.
[15] JPDO "Next Generation Air Transportation System – Integrated Plan," December 2004.

faces difficult challenges in keeping agency investments synchronized with user investments. To maintain support for NGATS initiatives, the JPDO and FAA need to articulate how problems that affected past modernization efforts will be mitigated and what specific skill sets with respect to software development and system integration will be required. This will help reduce cost and schedule problems with NGATS initiatives.

JPDO and FAA officials told us that they intend to rely on demonstration projects with participating agencies and airspace users to get a better understanding of potential cost and benefits of NGATS initiatives. We agree but think that demonstration projects should also be designed to provide insight into the range of the policies and procedures that must be changed to get the expected benefits. These demonstration projects should also identify certification issues and safety requirements needed to move from demonstrating a capability to full-scale development and implementation.

To help manage the transition to NGATS, FAA is considering whether or not a *lead systems integrator*—a private contractor that would help link new and existing systems and help manage other contractors—will be required. DOD has relied on this for complex weapon systems. Models for using a lead system integrator throughout the Government differ with respect to roles and responsibilities. We note that FAA has used a systems engineering and integration contractor in the past to help integrate modernization projects, but questions about the role, responsibility, and expected costs will need to be examined.

Clarifying Approaches for Industry Participation To Prevent Potential Conflict of Interest

The JPDO established the NGATS Institute in 2005 specifically to allow industry to participate in shaping NGATS. Currently, industry representatives are participating in JPDO IPTs. The JPDO's March 2006 progress report noted that over 140 industry and private sector participants (from 66 organizations) are involved in IPT planning efforts.

Industry groups have expressed concern that participation in JPDO activities might preclude them from bidding on future FAA acquisitions related to NGATS because it may create an organizational conflict of interest. Generally speaking, FAA's Acquisition Management System precludes contractors from competing on production contracts if the contractor either participated in or materially influenced the drafting of specifications to be used in future acquisitions for production contracts or had advance knowledge of the requirements.

FAA is aware of the industry's concern and is working to ensure that industry participation does not result in organizational conflicts of interest. JPDO officials believe—and we agree—that resolving this issue will be essential to get the desired skill and expertise from industry.

Recently, the JPDO revised the contracting mechanism with the NGATS Institute to address this issue. Specifically, the JPDO and the Institute have committed to develop procedures to avoid organizational conflicts of interest. Putting these procedures in place will help get and sustain the desired expertise from industry and help prevent problems in the future.

We believe that the JPDO needs to continue to foster awareness of potential conflicts of interest among IPTs and its contractors to identify information that might later lead to conflicts of interest. It will be particularly important for FAA and the JPDO to monitor these matters as the role of the JPDO evolves and various efforts shift from planning to implementation.

Examining and Overcoming Barriers To Transforming the National Airspace System That Have Affected Past FAA Programs

Our work on many major acquisitions shows the importance of clearly defined transition paths, expected costs (for both FAA and airspace users), and benefits (reduced delays). This is particularly the case for initiatives that require airspace users to equip with new avionics.

For example, FAA canceled the controller-pilot data-link communications program because of uncertain benefits, concerns about user equipage, cost growth, and the impact upon the Agency's operations account. The inability to synchronize the data-link program with other modernization efforts, such as the multibillion-dollar En Route Automation Replacement Program, was also a factor.

Other critical barriers to be overcome include ensuring that new systems are certified as safe for pilots to use and getting expertise in place at the right time. These will be critical when ADS-B is being fielded nationwide. For example, FAA's multibillion-dollar Wide Area Augmentation System's (a new satellite navigation system) problems were directly traceable to problems in testing and certification.

The September 20, 2005, REDAC report[16] on barriers to transitioning air traffic management research into operational capability underscores the importance of certification and safety issues:

> The aviation community continues to be concerned that certification requirements can be initially uncertain, may evolve late in the program, and take too long to meet. There is a related concern that methods do not exist to certify increasingly complex future integrated air-ground systems…. There is also concern that if avionics requirements are directly applied to ground systems without accounting for the different safety-of-flight considerations, system certification may be unnecessarily difficult.

As we reported in congressional testimonies, it will be important for FAA to stay engaged in the certification process for JPDO initiatives. This will help reduce risks for cost increases, schedule slips, and diminished resources.

Developing a Strategy for Technology Transfer

Technology transfer—the movement of technology from one organization to another—is a central issue for the JPDO because the law envisions new capabilities developed by other Federal agencies (or the private sector) being transitioned into the National Airspace System. The JPDO will have to pay greater attention to this matter as it moves forward to reduce development times with NGATS initiatives.

Our past work shows that FAA has experienced mixed results in transitioning systems developed by others into the National Airspace System. For example, FAA ultimately abandoned work on a promising new controller tool developed by NASA (the Passive Final Approach and Spacing Tool) for sequencing and assigning runways to aircraft because of complex software development (including site-specific customization) and cost issues and because the benefits were unlikely transferable to other airports.

This issue surfaced again in a recent National Research Council report[17] that examined NASA's aeronautical research efforts. Specifically, the report stated that:

> …too many NASA aeronautics projects stopped short of full demonstration of their technical success and utility to users. Experience shows that a potential innovation must be reduced to practice in the complex environment

[16] FAA REDAC report, "Transitioning Air Traffic Management Research into Operational Capabilities," September 20, 2005.

[17] National Research Council report, "Aeronautics Innovation, NASA's Challenges and Opportunities," 2006.

in which it will function before it will be accepted as credible and adopted by the target user community.

As we noted in our review of FAA's Free Flight Phase 1 Program,[18] the use of "technology readiness levels"[19] could be useful to help assess maturity of systems and ease issues associated with the transfer of technology. Stated simply, it is the problem of efficiently transitioning a new technology from concept to viable product in the shortest possible time and at the least cost. Both NASA and DOD have experience with categorizing technology maturity, which could help reduce cost, schedule, and technical risks with implementing JPDO initiatives. A JPDO official pointed out that efficient transition of new technologies will also require close cooperation between researchers and users of existing systems. This could include the establishment of "transition" or "maturation" teams to create a developmental pipeline for new systems.

Conducting Sufficient Human Factors Research To Support Anticipated Changes

The JPDO is planning to make fundamental changes in how the National Airspace System operates and how controllers manage traffic to accommodate three times more aircraft in the system. Currently, the union that represents controllers is not yet participating in JPDO efforts, but it needs to be. Additionally, changes must address cultural issues within FAA that could potentially inhibit the implementation of NGATS; this will require doing business differently than the way it is done with the current system.

History has shown that insufficient attention to human factors can increase the cost of acquisition and delay much needed benefits. For example, problems in the late 1990s with FAA's Standard Terminal Automation Replacement System were directly traceable to not involving users early enough in the process.

The need for focused human factors research extends well beyond the traditional computer-machine interface (such as new controller displays) and has important workforce and safety implications. For example, FAA expects the controller's role to change from direct, tactical control of aircraft to one of overall traffic management. There also will be significant human factors concerns for pilots, as they will be expected to rely more on data-link communications.

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[18] OIG Report Number AV-2002-067, "Free Flight Phase 1 Technologies: Progress to Date and Future Challenges," December 14, 2001.

[19] Technology Readiness Levels – DOD and NASA use a nine-point scale to differentiate the maturity of technologies Level 1 (Basic Principles Observed and Reported) to Level 9 (Actual System, Proven Through Successful Mission Operations). Source: GAO Report GAO/NSIAD-99-162, "Better Practices, Better Management of Technology Development Can Improve Weapon System Outcomes," July 29, 1999 and OIG Report Number AV-2002-067, "Free Flight Phase 1 Technologies: Progress to Date and Future Challenges," December 14, 2001.

Key issues for human factors research focus on what can reasonably be expected of new automation systems and cockpit displays. The following issues identified in FAA's concept of operations for NGATS will require additional human factors work:

- How will increased automation and new technologies affect flight crew workload?
- What effect do the changing roles and responsibilities have on safety?
- What alerts and information displays does a pilot need to safely oversee conflict detection and resolution when no one on the ground is responsible for tactical separation?
- If automation fails, what is the back-up plan in terms of people, procedures, and automation?

FAA will have to prioritize its ongoing human factors work and make sure it is targeted to address critical issues affecting controllers and pilots. This will also require close cooperation with NASA, which also conducts human factors research. We agree with the JPDO that simulations and modeling will be important to gain a full understanding of the human factors issues and corresponding requirements for NGATS initiatives.

RECOMMENDATIONS

The transition to NGATS is an enormously complex undertaking that will span years and require considerable investments from both the Government and airspace users. We shared our views with the JPDO and FAA on the range of actions needed to shift from a research agenda to one of implementation, and actions are underway to address our concerns about better linking JPDO and ATO efforts.

To help better manage NGATS efforts, we recommend that the Federal Aviation Administrator:

1. Report NGATS cost data along three vectors—developmental efforts, adjustments to existing programs, and NGATS implementation—when reporting NGATS financial requirements to Congress and stakeholders.

2. Determine the level of technical maturity of NASA's research projects developed for NGATS initiatives. If NASA will be unable to provide research projects at a level that FAA can quickly move to prototype development, then FAA will need to develop contingency plans for how this research and development will be conducted, managed, and paid for.

3. Review existing ongoing modernization programs to determine if they are still needed and, if so, what adjustments in cost, schedule, and performance parameters will be needed.

4. Include information in the annual JPDO progress report on specific research projects with budget data for FAA developmental efforts as well as budget data of other agencies that are being leveraged and specify how the ongoing research is supporting the JPDO.

5. Determine what skill sets and expertise, with respect to software development and system integration, will be required by the ATO and JPDO—and how they will be obtained—to manage and execute NGATS initiatives.

6. In planned NGATS demonstration projects, develop sufficient data to establish a path for certifying new systems and identify the full range of adjustments to policies and procedures needed to get benefits.

7. Continue to develop and refine procedures that address conflict of interest issues with JPDO initiatives and conduct annual reviews of the matter as the role of the JPDO evolves from planning to implementation.

8. Use technology readiness levels in assessing the maturity of research conducted at other agencies to help speed technology transfer and the introduction of new capabilities into the National Airspace System.

9. Fund targeted human factors research to ensure that the changing roles of controllers and pilots envisioned by the JPDO can safely be accommodated. This will require a re-prioritization of ongoing efforts at FAA and close cooperation with NASA, which also conducts human factors research.

MANAGEMENT COMMENTS AND OIG RESPONSE

On December 15, 2006, we provided FAA with a draft copy of this report. On February 9, 2007, FAA gave us its formal response, which is included in its entirety in the Appendix. FAA concurred with the following eight recommendations, and we consider them resolved:

- Report NGATS cost data and development efforts to Congress and stakeholders along three vectors,
- Determine the level of technical maturity of NASA's research and development projects related to NGATS,
- Review ongoing modernization efforts and determine what adjustments must be made,
- Report in JPDO's annual progress report research and budget data of FAA and partner Agencies that are being leveraged for use in NGATS,
- Determine critical skill sets and expertise that will be required with respect to software development and system integration,
- Develop NGATS demonstration projects that will develop sufficient data to establish pathways to certification,
- Continue to develop and refine procedures to address conflicts of interest issues with JPDO initiatives,
- Fund human factors research that will address changing roles of pilots and controllers.

FAA partially concurred with Recommendation 8 to use technology readiness levels in assessing the technical maturity of research and development projects received from partner agencies. FAA points out that the use of technology readiness levels alone does not facilitate successful technology transfer. We agree and point out in our report that efficient transition of technology also requires close cooperation between researchers and users of existing systems. In its response, FAA points to a number of steps, such as further developing the concept of operations and the NGATS R&D plan and using the Agency's Operational Evolution Plan to track technology maturity. We consider FAA's alternative actions responsive to the intent of this recommendation.

EXHIBIT A. KEY RESEARCH EFFORTS NEEDED FOR NGATS

Based upon our work and understanding of the JPDO interim capabilities, the concept of operations, and the REDAC report, the following are examples of several key research and development activities that are underway or planned by NASA and others that will be essential in realizing the expected capacity benefits from NGATS.

- **Automation Improvements.** Research is needed to develop automation that performs routine separation and traffic flow management functions with almost flawless performance. It will be important to determine the optimum roles for controllers and pilots in a highly automated system that shifts greater responsibility to the pilot.
- **Separation Standards for an Automated Environment.** Research is needed to assess current separation standards, which have created a remarkably safe system. Work is required to determine what is achievable and how mishaps can be accommodated.
- **Cockpit Displays.** Research is needed for a cockpit-based display that will enable pilots to self-separate.
- **Weather Integration Into Automation.** Research is needed to design and develop systems that integrate up-to-date weather information into automation systems that identify hazardous weather (e.g., thunderstorms, in-flight icing, and turbulence) for all phases of flight.

Overall, FAA's concept of operations for NGATS has identified over 70 research or policy areas that require further investigation. These research areas will be needed regardless of the technology ultimately selected. Some research on these issues is planned or has been done in the past. To see benefits in the 2012 timeframe, as projected by the JPDO, FAA officials have told us that work must begin now, given the lag time between development and actual deployment. It is not yet clear who or what agency will do this research. To be effective, the research must also focus on policies, procedures, and methods for certifying systems as safe for use.

EXHIBIT B. POTENTIAL AGENCY CONTRIBUTIONS

Agencies participating in the JPDO are conducting a wide range of research for their specific missions. We note that only some of the ongoing research will be applicable to the JPDO's efforts.

Table 2. Federal Agencies and Their Key Leverage Areas

Agency	Key Area of Leverage
Department of Defense (DOD)	DOD has an extensive and diverse Research and Development (R&D) base, including research in new aircraft, composites, imaging systems, and data exchange systems for all services. DOD has requested $73 billion overall for R&D in FY 2007. The JPDO is particularly interested in DOD's broadband communication networks, such as the *Global Information Grid*. DOD planned upgrades to the Global Positioning System Constellation will be critical to civil aviation.
Department of Commerce/ National Oceanic and Atmospheric Administration (NOAA)	Commerce is requesting $1.1 billion for research in FY 2007. NOAA is a part of Commerce and is responsible for the National Weather Service; the National Environmental Satellite, Data, and Information Service; and Oceanic and Atmospheric Research. NOAA requested $533 million in FY 2007 for R&D. The JPDO is seeking from NOAA probability weighted forecast capabilities, a national uniform weather database of forecasts and observations, and transparent automatic adjusted traffic management for weather.
National Aeronautics and Space Administration (NASA)	For years, NASA has conducted the majority of long-term Air Traffic Management research, including automated controller tools and human factors work. NASA has requested $724 million for aeronautical R&D for FY 2007. The JPDO is looking to NASA to develop automated aircraft metering and sequencing and dynamic airspace reconfiguration.
Department of Homeland Security (DHS)	DHS contributes expertise in the areas of security and net-centric initiatives. The Agency has requested $1 billion in FY 2007 for Science and Technology R&D. FAA is looking to DHS to develop automated passenger and cargo screening, hardened aircraft security, and flight control overrides.

EXHIBIT C. INTEGRATED PRODUCT TEAMS AND THEIR LEAD AGENCIES

Integrated Product Teams are multi-agency teams that are defining the specific concepts and capabilities and coordinating the actions necessary to make the transformation possible in each of the eight strategies of the NGATS Integrated Plan. We understand that the JPDO will restructure its IPTs sometime in 2007. The following represents the structure at the IPTs at the time of our review.

1. Develop Airport Infrastructure To Meet the Future Demand – FAA
2. Establish an Effective Security System Without Limiting Mobility or Civil Liberties – DHS
3. Establish an Agile Air Traffic System – NASA
4. Establish User-Specific Situational Awareness – DOD
5. Establish a Comprehensive Proactive Safety Management Approach – FAA
6. Develop Environmental Protection That Allows Sustained Aviation Growth – FAA
7. Develop a System-Wide Capability To Reduce Weather Impacts – Commerce/NOAA
8. Harmonize Equipage and Operations Globally – FAA

EXHIBIT D. KEY PLATFORMS

Table 3. Issues With FAA Systems

System	Status and Key Issues
Terminal Modernization: Standard Terminal Automation Replacement System (STARS), Common Automated Radar Terminal System (Common ARTS): Controller work-stations that process surveillance data and display it on-screen to manage air traffic in the terminal environment.	FAA has struggled with how to complete terminal modernization. STARS, which so far has cost of $1.3 billion for only 47 sites, was envisioned as the centerpiece of terminal modernization. Because of technical problems and schedule delays with STARS, FAA decided to deploy another system, Common ARTS, as an interim solution at over 140 facilities in several configurations. FAA is rethinking its approach to terminal modernization and recently decided to field STARS to only five additional sites. A decision affecting the remaining 100-plus sites has been postponed for over a year. FAA needs to resolve how it will complete terminal modernization and what additional capabilities will be needed as it works with the JPDO.
En Route Automation Modernization (ERAM): Replaces the Host computer hardware and software (including the Host backup system) and associated support infrastructure at 20 En Route Centers.	With an estimated cost of $2.1 billion, ERAM is one of the largest and most complex acquisitions in FAA's modernization portfolio. Progress is being made with the first ERAM deliverable—a back-up system for the Host computer. However, the bulk of the work focuses on developing the first major ERAM software release, which involves developing over 1 million lines of code. A number of new capabilities (e.g., dynamic airspace management and data link) depend on future enhancements to ERAM that have yet to be defined or priced.

System	Status and Key Issues
FAA Telecommunications Infrastructure (FTI) is designed to replace existing telecommunications networks with one new network through a phased process. A single provider is responsible for acquiring, operating, and maintaining the new telecommunications infrastructure.	FTI is FAA's effort to transition from multiple telecommunication networks to a single new network to reduce operating costs. FTI is expected to replace about 20,000 existing telecommunications services and circuits at more than 4,000 facilities. FAA re-baselined FTI in August 2006, increasing Agency telecommunications lifecycle costs from $3.2 billion to $3.3 billion. In addition, FAA has added another year to the FTI schedule and plans to complete the effort in December 2008. This delay occurred because FAA did not have a realistic master schedule or effective transition plan identifying when each site and service would be accepted, when services would be cut over to FTI, and when existing services would be disconnected. By the end of FY 2006, FTI equipment was installed at more than 1,000 sites, and about 35 percent of 20,000 planned FTI services were operational, leaving a vast amount of existing equipment still being sustained. As a result, expected FTI cost reduction benefits are eroding. FAA continues to face a number of risks with FTI, including complex transition issues. We are currently reviewing progress with FTI and will issue a report later this year.
Traffic Flow Management (TFM) is an FAA initiative to modernize the hardware and software used to manage the flow of air traffic.	Traffic Flow Management Infrastructure products and services are designed to support the Traffic Management Specialists and Traffic Management Coordinators in optimizing air traffic flow across the National Airspace System. The specialists and coordinators analyze, plan, and coordinate air traffic flow through continuous coordination with the airlines and the use of surveillance sources, weather, automation, and display subsystems.

EXHIBIT E. OBJECTIVES, SCOPE, AND METHODOLOGY

At the request of the Chairman and Ranking Member of the House Aviation Subcommittee, we initiated a review of the newly established JPDO to assess progress to date. As agreed with the Subcommittee, we focused this report on (1) accessing JPDO's progress to date in aligning diverse agency budgets and what barriers remain to be overcome and (2) determining actions that will help the JPDO move from planning to implementation.

To get an understanding of the challenges FAA faces with NGATS, we gathered and reviewed budgetary documentation for key projects, including the top 10 largest ongoing acquisitions in terms of dollars. We also examined cost and schedule reports for key projects, such as FTI, and their funding profiles contained in FAA's Capital Investment Plan. In addition, we examined the progress and issues associated with SWIM and ADS-B—two key projects highlighted in the JPDO's recent progress report to Congress. To understand the potential affects to ongoing projects, we interviewed key JPDO personnel responsible for developing NGATS and senior FAA management, including the Director of FAA's Capital Expenditures Programs.

To determine progress to date with coordination and alignment of JPDO partner agencies, we collected information from the eight IPTs with respect to plans and what ongoing research that could be leveraged by the JPDO. We focused the majority of our work on the IPTs that relate directly to air traffic management. Additionally, we interviewed NASA's Associate Administrator for Aeronautical Research and members of her staff and FAA budget office staff. We gathered applicable program documentation from FAA and reviewed relevant Agency documents, such as the 2005 JPDO Progress Report to Congress.

To determine the range of actions needed to shift from planning to implementation, we interviewed officials from FAA, ATO, NASA, JPDO, and the aviation industry. Also, we reviewed a recent report by the National Research Council that highlighted the need for changes with the JPDO's IPTs. In addition, we attended the April 2006 JPDO/Industry Workshop on NGATS costs, as well as an expert panel sponsored by the U.S. Government Accountability Office and facilitated by the National Academy of Sciences.

We performed our survey and verification work from July 2005 through September 2006. We performed our work in accordance with Generally Accepted Government Auditing Standards as prescribed by the Comptroller General of the United States.

APPENDIX. MANAGEMENT COMMENTS

Federal Aviation Administration

Memorandum

Date: FEB — 8 2007 (February 8, 2007)

To: David A. Dobbs, Principal Assistant Inspector General for Auditing and Evaluation

From: Ramesh K. Punwani, Assistant Administrator for Financial Services/CFO

Prepared by: Anthony Williams, x79000

Subject: OIG Draft Report: Joint Planning and Development Office: Actions Needed to Reduce Risk with the Next Generation (NextGen) Air Transportation System

In the subject draft report dated December 15, 2006, the Federal Aviation Administration (FAA) was requested to provide written comments to be incorporated into your final report.

The following is FAA's response to each of your recommendations.

Recommendation 1: Report NGATS cost data along three vectors—developmental efforts, adjustments to existing programs, and NGATS implementation when reporting NGATS financial requirements to Congress and stakeholders.

FAA Response: Concur. In early 2007, Congress will receive the FAA's reauthorization proposal, which will include budget projections consistent with the reauthorization period. The projections include base FAA programs and incremental NextGen funding for RE&D and ATO Capital appropriations.

In February, subject to OMB approval, Congress will receive the JPDO Annual Progress Report, which will include initial 5-year, 10-year, and end state cost projections for NextGen.

JPDO will be building a comprehensive cost estimate throughout this fiscal year. The results will support the FY 2009 budget process and associated out-year planning.

Recommendation 2: Determine the level of technical maturity of NASA's research projects developed for NGATS initiatives. If NASA will be unable to provide research projects at a level that FAA can quickly move to prototype development, then FAA will need to develop contingency plans for how this research and development will be conducted, managed, and paid for.

FAA Response: Concur. By August 31, JPDO will develop an R&D Plan that identifies responsibilities of JPDO member agencies for the NextGen pre-implementation work leading to agency implementation decisions. The pre-implementation work includes foundational research, applications research, policy and benefits analyses, and system engineering.

Recommendation 3: Review existing ongoing modernization programs to determine if they are still needed and, if so, what adjustments in cost, schedule, and performance parameters will be needed.

FAA Response: Concur. As part of its resource planning activities with the partner agencies, and based on the enterprise architecture roadmap, JPDO will identify those capital programs that are still needed to support NextGen and what adjustments will be needed. The architecture roadmap will also inform FAA funding priorities by indicating how long legacy technologies will be needed before new technologies/capabilities are transitioned into the NAS.

Recommendation 4: Include information in the annual JPDO progress report on specific research projects with budget data for FAA developmental efforts as well as budget data of other agencies that are being leveraged and specify how the ongoing research is supporting the JPDO.

FAA Response: Concur. The Progress Report will contain a high level description of the specific research projects in the partner agencies and how they contribute to NextGen. More detailed descriptions of the program elements will be available in the budget white sheets that accompany the President's FY 2008 budget. For the FY 2009 budget formulation cycle, this information will be formalized in the NextGen Exhibit 300 and the NextGen R&D Plan, which will be completed in time for submission with the agency budgets.

Recommendation 5: Determine what skill sets and expertise, with respect to software development and system integration, will be required by the ATO and JPDO—and how they will be obtained—to manage and execute NGATS initiatives.

FAA Response: Concur. ATO will work with the Chairman of the Research, Engineering and Development Advisory Committee National Airspace System Subcommittee to form a panel of external government and industry experts to conduct an independent assessment of the ATO's ability to successfully integrate the operational improvements required to transition to NextGen. Recommendations will be sought as to how best achieve NextGen implementation. This work will be completed by the end of September.

Appendix. Management Comments

Recommendation 6: In planned NGATS demonstration projects, develop sufficient data to establish a path for certifying new systems and identify the full range of adjustments to policies and procedures needed to get benefits.

FAA Response: Concur. FAA has redefined the successful Operational Evolution Partnership (OEP) to serve as the framework that will guide, monitor and report the transition to NextGen. The OEP process now spans all phases of NextGen development and establishes the path from concept validation, to applications research, through system engineering, to acquisition and implementation. Participation by all relevant FAA executives ensures that the full range of changes (technology, training, policy, certification, and procedures) come together at the right time to achieve operational benefits. The next publication date of the annual OEP plan is scheduled for June.

Recommendation 7: Continue to develop and refine procedures that address conflict of interest issues with JPDO initiatives and conduct annual reviews of the matter as the role of the JPDO evolves from planning to implementation.

FAA Response: Concur. On the basis of the work planned for this fiscal year, JPDO will consult with FAA's legal counsel and develop and deliver appropriate awareness training for private sector participants in JPDO activities. The training for this fiscal year will be completed by March 30. JPDO will conduct similar assessments and training each year.

Recommendation 8: Use technology readiness levels in assessing the maturity of research conducted at other agencies to help speed technology transfer and the introduction of new capabilities into the National Airspace System.

FAA Response: Partially concur. Use of technology readiness levels does not by itself facilitate technology transition. However, we agree that a smooth technology maturation pipeline is needed to speed introduction of NextGen capabilities. Several factors and actions should help to assure that smooth pipeline: (1) the NextGen Operational Concept provides the operational "pull" that is often missing in technology maturation; (2) the NextGen R&D Plan will identify responsibilities of JPDO member agencies for the NextGen technology requirements; and (3) at the FAA, use of the OEP to plan and track technology maturation provides the leadership that is critical to successful tech transfer.

Recommendation 9: Fund targeted human factors research to ensure that the changing roles of controllers and pilots envisioned by the JPDO can safely be accommodated. This will require a re-prioritization of ongoing efforts at FAA and close cooperation with NASA, which also conducts human factors research.

FAA Response: Concur. By August 31, JPDO will develop an R&D Plan that will identify responsibilities of JPDO member agencies for the NextGen technology requirements, including human factors research.

The following pages contain textual versions of the graphs and charts found in this document. These pages were not in the original document but have been added here to accommodate assistive technology.

Joint Planning and Development Office: Actions Needed To Reduce Risks With the New Generation Air Transportation System

Section 508 Compliant Presentation

Figure 1. United States Commercial Air Carriers System Enplanements, Fiscal Years 2005 to 2007 (Passenger figures are in millions)

Fiscal Year	Mainline Passengers	Regional Passengers
2005	587.3	151.4
2006	584.7	155.9
2007	604	165.1
2008	621.8	171.8
2009	640.1	179.6
2010	659.6	187.6
2011	679.6	195.9
2012	700.8	204.4
2013	722.6	213.1
2014	745.6	222.1
2015	769.4	231.3
2016	794.5	240.8
2017	821.1	250.4

Source: Federal Aviation Administration Forecast 2005-2017

Figure 2. The Federal Aviation Administration's Fiscal Year 2007 Facilities and Equipment Budget Request

Category	Amount Requested	Percentage of Total Request
Personnel and Related Expenses	$447,900,000	18 percent
Mission Support	$282,000,000	11 percent
Facilities	$402,000,000	16 percent
Air Traffic Control Modernization	$1,370,000,000	55 percent

Source: The Federal Aviation Administration's Fiscal Year 2007 Budget Request