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THE NEXT GENERATION AIR TRANSPORTATION SYSTEM: STATUS AND ISSUES

HEARING

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

SECOND SESSION

SEPTEMBER 11, 2008

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THE NEXT GENERATION AIR TRANSPORTATION SYSTEM: STATUS AND ISSUES

THURSDAY, SEPTEMBER 11, 2008

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Committee met, pursuant to call, at 10:05 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Bart Gordon [Chairman of the Committee] presiding.

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515

Hearing on

The Next Generation Air Transportation System: Status and Issues

September 11, 2008
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESS LIST

Ms. Victoria Cox
Senior Vice President for NextGen & Operations Planning
Air Traffic Organization
Federal Aviation Administration

Dr. Gerald L. Dillingham
Director
Physical Infrastructure Issues
Government Accountability Office

Hon. Calvin L. Scovel III
Inspector General
U.S. Department of Transportation

Dr. Paul G. Kaminski
Chairman and CEO
Technovation Inc.

Professor Ian A. Waitz
PARTNER Director
Massachusetts Institute of Technology

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HEARING CHARTER

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

The Next Generation Air Transportation System: Status and Issues

THURSDAY, SEPTEMBER 11, 2008
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Thursday, September 11, 2008 at 10:00 am, the Committee on Science & Technology will hold a hearing to examine the status of the Next Generation Air Transportation System initiative known as NextGen and explore key issues related to the initiative and the interagency Joint Planning and Development Office (JPDO), the organization entrusted with NextGen planning and research coordination.

Witnesses:

Ms. Victoria Cox, Senior Vice President for NextGen & Operations Planning, Air Traffic Organization, Federal Aviation Administration

Dr. Gerald L. Dillingham, Director, Physical Infrastructure Issues, Government Accountability Office

Mr. Calvin L. Scovel III, Inspector General, U.S. Department of Transportation

Dr. Paul G. Kaminski, Chairman and CEO, Technovation Inc.

Professor Ian A. Waitz, PARTNER Director, Massachusetts Institute of Technology

BACKGROUND

Issues

The following issues are expected to be raised at the hearing:

- *Have the specific and real improvements projected to be gained through NextGen been well defined, are they realistic, and is there a stakeholder consensus in support of them?*
- *What metrics should Congress use to evaluate the progress of the NextGen initiative?*
- *In light of the extremely complex systems engineering challenge facing the NextGen initiative, what will the NextGen interagency partnership and other stakeholders need to do to maximize its chances for success?*
- *Have the views of industry, active air traffic controllers, and technicians who maintain the ATC system been adequately incorporated in NextGen foundational planning documents, such as the Concept of Operations, Enterprise Architecture, and Integrated Work Plan?*
- *Have the research and development (R&D) expectations established by Vision 100—the legislation establishing the framework for NextGen—been met by the JPDO and its stakeholders?*
- *What needs to be done to move the JPDO from a position of proposing the R&D necessary for the success of NextGen to one of articulating a clear R&D program with defined and prioritized tasks for each of the partner agencies?*
- *How confident should Congress be that progress in meeting the research, development and testing activities set out in the JPDO's Integrated Work Plan will provide a sufficient basis for achieving the NextGen's goals and timetable for quieter, cleaner, and more efficient air traffic operations?*
- *Does the current form of the Integrated Work Plan have sufficient detail and priorities to allow it to be effectively used to oversee and manage the NextGen-related R&D efforts of multiple agencies?*

- *What major omissions did the JPDO find when it performed its recent research gap analysis, and how are they being addressed? Did the gap analysis indicate areas in which partners, other than the Federal Aviation Administration (FAA) and National Aeronautics and Space Administration (NASA), need to play a greater role in furthering the NextGen initiative?*
- *What has to happen for FAA to be able to successfully carry out its intent to accelerate the transition from the JPDO's system concepts and R&D activities to the implementation of operational systems without sacrificing the focus needed to ensure that NextGen's long-term benefits of increased system capacity, lower energy consumption, and reduced environmental impacts will be achieved?*
- *Given the impact of aviation on the environment, including climate, what steps should the NextGen initiative take to mitigate that impact?*
- *What assumptions regarding the maturity of near-term and long-term research and technologies were made as part of the decision to reorganize NextGen and JPDO in FAA?*
- *Can the JPDO continue to be viewed as an "honest broker" by the other participating agencies in light of the recent restructuring action by FAA?*
- *How will FAA and its federal partners ensure that the JPDO and NextGen program adhere to budget and schedule milestones during the upcoming Presidential transition? Will momentum and program focus be impacted by transition activities?*

Overview

While the health of the National Airspace System (NAS) is critical to America's economy, the current approach to managing air transportation is becoming increasingly inefficient and operationally obsolete. Today's NAS is near capacity, with delays growing to record levels, yet a threefold increase in air traffic is expected by 2025. Current processes and procedures do not provide the flexibility nor the scalability needed to meet the growing demand.

In 2003, Congress created the Joint Planning and Development Office (JPDO) as part of P.L. 108–176, *Vision 100: Century of Flight Reauthorization Act.* The JPDO is to plan for and coordinate, with federal and non-federal stakeholders, a transformation from the current air traffic control system to the NextGen by 2025. NextGen is envisioned as a major redesign of the air transportation system that will entail precision satellite navigation; digital, networked communications; an integrated aviation weather system; layered, adaptive security; and more.

Seven organizations are participating in the JPDO: the Departments of Transportation, Commerce, Defense, and Homeland Security; FAA; NASA; and the White House Office of Science and Technology Policy. The JPDO is housed within FAA, and FAA's FY 2009 budget request includes $19.5 million to support JPDO. While the JPDO has the planning and development responsibility and can define R&D requirements that it would like the participating agencies to carry out, it has neither budgetary nor management authority over the agencies' activities in support of NextGen. Although the JPDO is responsible for planning the transformation to NextGen and coordinating the related research and development efforts of its partner agencies, FAA is largely responsible for implementing the policies and systems necessary for NextGen, while continuing to safely operate the current air traffic control system 24 hours a day, seven days a week.

The JPDO envisions that NextGen will be an evolutionary transformation of the Nation's air transportation system that integrates a combination of new procedures and advances in technology to improve delivery of services to both civil and military users. The goal of NextGen, as stated by the JPDO, is to *"significantly increase the safety, security, capacity, efficiency, and environmental compatibility of air transportation operations, and by doing so, to improve the overall economic well-being of the country."* The JPDO's role is to establish how the air transportation system should be transformed. Part of this transformation involves integrating and reshaping capabilities across all aspects of air transportation so that the entire system operates as an interconnected structure.

The JPDO sees the investments in NextGen resulting in increased system capacity and flexibility to accommodate growing demand for air transportation services and diversity of flight profiles. In its planning documents, the JPDO describes building NextGen in three phases, which it characterizes as *Epochs.*

- In Epoch 1 [Foundational Capabilities (2007–2011)], focus will be on developing and implementing mature foundational technologies and capabilities such as Automatic Dependent Surveillance—Broadcast (ADS–B) which is the

surveillance and navigation technology that will serve as the core of the NextGen system by delivering more timely and precise information to the cockpit while giving pilots and controllers a common operational picture.

- In Epoch 2 [Hybrid System (2012–2018)], the required automation and procedures are implemented to allow pilots a more active role in the system through self-separation, merging, and passing. According to the JPDO, by the completion of Epoch 2, operational improvements and fleet evolution will provide a number of environmental benefits such as increased fuel efficiency at 34 FAA-designated airports within the continental United States. For example, in the terminal airspace operations area, NextGen capabilities and improvements in aircraft engine technologies will, according to the JPDO, produce an overall improvement in fuel efficiency estimated at six percent compared to the baseline. This will have a commensurate positive effect on reducing the level of emissions generated.
- The JPDO views Epoch 3 [NextGen Operations (2019–2025)] as the expansion of NextGen into a nationwide system which also allows for more complex, high-density operations across the system to take full advantage of the airspace and the precision provided by satellite-based technologies that will be fully deployed by then.

NextGen Funding

Preliminary benefits analyses by the JPDO indicate that NextGen capacity increases could yield significant economic growth. As stated in its Business Case released in August 2007,[1] using data derived from the joint FAA/NASA 2004 Socioeconomic Demand Forecast (SEDF) study on aviation demand, the JPDO estimated *"a rough-order-of-magnitude annual economic value of $3,000 per flight. Every additional flight accommodated by expected NextGen capacity gains represented an economic benefit, whereas every additional flight that cannot be accommodated represented an economic loss."* The JPDO found that *"preliminary results from the SEDF study indicate that the cumulative positive impact to consumer surplus resulting from estimated NextGen capacity gains is expected to be up to $80 billion by the end of Epoch 2 (2018) and as much as $176 billion by the end of Epoch 3 (2025)."* The JPDO notes that these benefits are not achievable without investments by the government and industry: Initial estimates of the FAA investment required to achieve the NextGen benefits are projected at $15 billion to $22 billion through 2025 and preliminary investment estimates by the aviation industry are projected to be in the range of $14 billion to $20 billion during this same time frame.[2]

NextGen investment over the next five years (from FY09 to FY13) including Research and Development is currently projected by the JPDO to total over $7.2 billion. Requested budgets by partner agencies for FY09 total $978.5 million. NextGen investments for FY08 through FY13 are shown in Table 1.

[1] JPDO, Business Case for the Next Generation Air Transportation System, Version 1.0 (Aug. 24, 2007).

[2] JPDO, Making the NextGen Vision a Reality: 2006 Progress Report to the Next Generation Air Transportation System Integrated Plan (Mar. 14, 2007).

Table 1: NextGen Investments FY08 through FY13

$ in millions						
Agency	**FY08** (Enacted)	**FY09** (Requested)	**FY10**	**FY11**	**FY12**	**FY13**
FAA (Capital, which includes NextGen Systems Development)	187.7	631.1	986.5	1,056.2	1,227.5	1,494.2
DOC/ NOAA (Capital)	2.6	3.7	3.7	3.7	3.7	3.7
Capital Subtotal	**190.3**	**634.8**	**990.2**	**1,059.9**	**1,231.2**	**1,497.9**
FAA (Safety and Operations)		0.7				
Safety and Operations Subtotal		**0.7**				
FAA (Research)	24.3	56.5	72.9	74.7	73.4	72.3
DOC/ NOAA (Research)	0.7	1.8	1.8	1.8	1.8	1.8
NASA (Research)	283.9	284.6	284.4	286.9	289.7	298.8
DHS (Research)						
DOD (Research)						
Research Subtotal	**308.9**	**342.9**	**359.1**	**363.4**	**364.9**	**372.9**
Total NextGen	**499.2**	**978.5**[3]	**1,349.3**	**1,423.3**	**1,596.1**	**1,870.8**

Source: Synthesized from JPDO-generated, NASA and FAA FY 2009 Budget data

[3] In FY2009, FAA's contribution to JPDO support is $19.5 million and is included in this total.

It should be noted that to date, the Department of Defense (DOD) and Department of Homeland Security (DHS) have not identified specific NextGen-related investments in their out-year budgets.

Uniquely establishing NextGen Research and Development costs[4] requires adding FAA's System Development activities funded in the agency's Capital Account to agencies' activities characterized as RE&D or R&D. Doing so shows that NextGen's projected Research and Development costs in the next five years are projected to total over $2.2 billion; requested budgets for NextGen Research and Development activities by partner agencies for FY09 total $384.3 million. The NextGen R&D activities from FY09 through FY13 are shown below in Table 2.

[4] The R&D costs in this table are components already included in the Table 1.

Table 2: NextGen R&D Activities FY09 through FY13

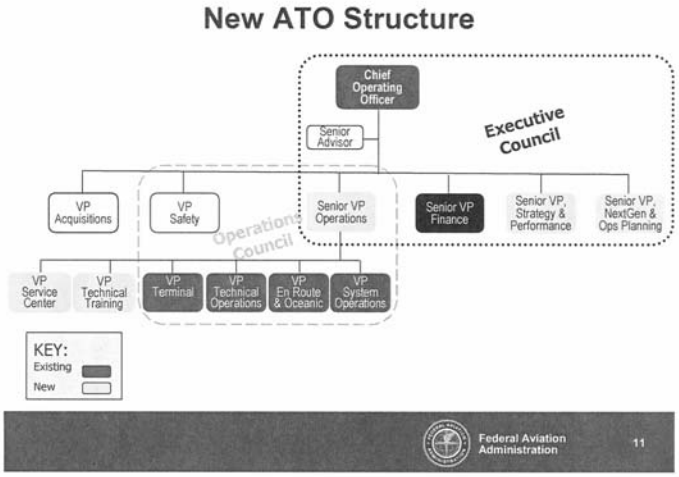
$ in millions						
Agency	**Activity**	**FY09** (Requested)	**FY10**	**FY11**	**FY12**	**FY13**
FAA NextGen System Development (From ATO Capital Account)	ATC/Tech Ops Human factors (Controller Efficiency)	3.8	11.7	11.7	11.7	11.7
	ATC/Tech Ops Human Factors (Air/Ground Integration)	2.9	7.7	7.7	7.7	7.7
	Environment & Energy (Noise and Emissions reduction)	2.5	12.5	12.5	12.5	12.5
	Environment & Energy (Validation Modeling)	4.5	7.5	7.5	7.5	7.5
	New ATM Requirement	5.4	27.5	27.9	29.2	31.9
	Operations Concept Development (Validation Modeling)	4.0	15.0	15.0	15.0	15.0
	System safety management Transformation	16.3	19	19.7	19.7	20
	Wake Turbulence (Re-categorization)	2.0	2.0	2.0	2.0	2.0
FAA NextGen R &D (From R,E&D Account)	Wake Turbulence	7.4	7.6	7.9	7.7	7.6
	Air Ground Integration	2.6	11.3	11.7	11.5	11.3
	Self Separation	8.0	9.8	10.1	10.0	9.8
	Weather Technology in the Cockpit	8.0	9.9	10.2	10.0	9.9
	Environmental Research—Aircraft Technologies, Fuels, and Metrics	16.1	19.7	20.4	20.0	19.7
DOC/ NOAA R&D	Various activities	1.8	1.8	1.8	1.8	1.8
NASA R&D	NextGen--Airspace	61.3	56.0	57.3	58.5	60.8
	NextGen—Airportal	13.3	16.7	16.9	16.9	17.5
	Aircraft Aging and Durability	10.6	11.3	11.2	12.0	12.4
	Integrated Intelligent Flight Deck	15.2	16.3	16.0	15.7	16.1
	Integrated Vehicle Health Management	19.7	19.9	18.8	18.6	19.2
	Integrated Resilient Aircraft Controls	17.1	18.5	19.0	18.2	18.8
	Subsonic Fixed Wing	89.0	85.9	88.3	89.4	91.5
	Subsonic Rotary Wing	23.2	23.9	24.0	24.2	25.2
	Supersonics	35.2	35.9	35.4	36.2	37.3
Total NextGen R&D		**384.3**	**462**	**467.4**	**470.2**	**481.2**

Source: Synthesized from JPDO-generated, NASA and FAA FY 2009 Budget data

Realignment of NextGen Activities and Responsibilities in FAA

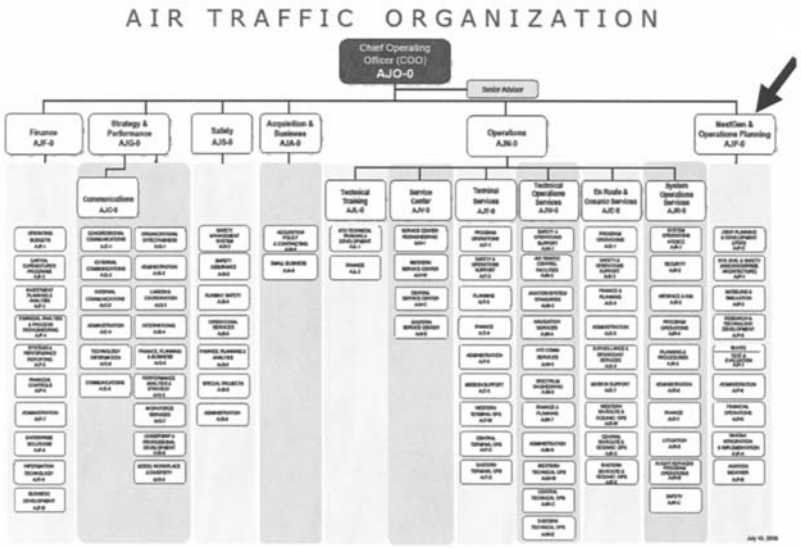
FAA recently realigned its NextGen activities and modified JPDO's position and status within the FAA. Organizationally, the agency added a Senior Vice President for NextGen and Operations Planning to the Air Traffic Organization (ATO). Arguing that the change would give FAA *"a clear decision-maker and a distinct line of authority on issues relating to NextGen,"* the FAA Acting Administrator designated Ms. Victoria Cox as the Senior Vice President responsible for NextGen and Operations Planning. [Ms. Cox, one of the hearing witnesses, will be able to provide an update on the status of this realignment.]

Prior to the recent realignment, the JPDO, which has always been housed in the FAA, reported to FAA's Administrator and the Chief Operating Officer of ATO. Today, the JPDO reports to the Senior Vice President for NextGen and Operations Planning, one of four Senior Vice Presidents in the ATO structure headed by the Chief Operating Officer and no longer reports directly to the FAA Administrator. This restructuring is contrary to the intent of the House-passed FAA Reauthorization bill [H.R. 2881], which envisions having the head of the JPDO report directly to the FAA Administrator and be a voting member of FAA's Joint Resources Council. The new ATO structure is shown on the following chart.



Source: FAA

In addition to the JPDO, the Senior Vice President for NextGen and Operations Planning has purview over Operations Planning as well as the newly established NextGen Integration and Implementation Office. According to FAA, the JPDO will maintain/revise the Integrated Work Plan; *"maintain the vision of the future"* and produce *"a long-term R&D Plan/Roadmap that demonstrates alignment across partner agencies performing long-term research";* and facilitate interagency cooperation. For its part, the newly formed Integration and Implementation Office has been tasked to *"ensure effective and efficient application, planning, programming, budgeting and execution of FAA's NextGen portfolio and manage NextGen portfolio across FAA lines of business."* Responsibility for the execution of individual acquisitions, such as Automatic Dependence Surveillance Broadcast (ADS–B), and System Wide Information Management (SWIM) would remain in operational units. The ATO organization and the units reporting to the Senior Vice President for NextGen and Operations Planning are shown on the next page.



Source: NextGen Senior Policy Committee Documentation

Aviation and the Environment

The NextGen initiative has, from the onset, recognized the need to consider aviation's impact on the environment. This is because environmental effects, such as noise level near airports and effects of aircraft emissions on local air quality, are known capacity limiters. Furthermore, aviation's contribution to climate change is becoming a major topic.

In his prepared statement presented at a hearing before the Space and Aeronautics Subcommittee in March 2007 on FAA's R&D Budget Priorities for Fiscal Year 2008, Dr. Donald Wuebbles, Chair of a workshop on the impacts of aviation on climate change (jointly sponsored by the JPDO's Environmental Integrated Product Team and the Partnership for Air Transportation Noise and Emissions Reduction Center of Excellence) summarized the findings and conclusions of his workshop as follows:

> *"As a key conclusion, the workshop participants acknowledged an urgent need for aviation-focused research activities to address the uncertainties and gaps in the understanding of current and projected impacts of aviation on climate and to develop metrics to better characterize these impacts. This effort will entail coordination with existing and planned climate research programs within government agencies, and could be organized through expansion of such programs or by totally new activities. The workshop participants indicated that such efforts should include strong and continuing interactions among the science and aviation communities as well as among policy-makers to develop well-informed decisions. The next steps required include further ranking and prioritizing of identified research needs; creating a research roadmap with associated roles and responsibilities of various participating agencies and stakeholders; and identifying resources needed to implement the roadmap."*

In addition, GAO testified before the House Committee on Transportation and Infrastructure's Subcommittee on Aviation in March 2008 [GAO–08–706T] and said:

> *"Aviation contributes a modest but growing proportion of total U.S. emissions, and these emissions contribute to adverse health and environmental effects. Aircraft and airport operations, including those of service and passenger vehicles, emit ozone and other substances that contribute to local air pollution, as well as carbon dioxide and other greenhouse gases that contribute to climate change. EPA estimates that aviation emissions account for less than one percent of local*

air pollution nationwide and about 2.7 percent of U.S. greenhouse gas emissions, but these emissions are expected to grow as air traffic increases."

The JDPO and its partners believe that there are uncertainties in our present understanding of the magnitude of climate impacts due to aviation emissions. In its most recent assessment, the Intergovernmental Panel on Climate Change (IPCC), a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP) has estimated that aviation in 2005 accounted for about three percent of worldwide anthropogenic radiative forcing. Because growth in demand is expected over the next few decades, the JPDO has identified the urgent need to understand and quantify the potential impacts of aviation emissions in its research program.

Such urgency is also needed in light of steps by the European Union (EU) to include both domestic and international aviation in an emissions trading scheme. The congressionally-directed report *Aviation and the Environment, A National Vision Statement, Framework for Goals and Recommended Actions* that was prepared by the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) in 2004 [Professor Ian Waitz, one of the hearing witnesses, participated in the study and may be able to provide additional details] said:

"The concerns extend well beyond American shores. For example, within the European Union (EU) the climate impacts of aviation are identified as the most significant adverse impact of aviation, in contrast to the United States and many other nations where air quality and noise are the current focus of attention. As a result, there are increasing EU calls for regulation-trading, taxes and charges, demand management and reduced reliance on aviation-even though there is large uncertainty in the understanding of the climate effects of aircraft and appropriate means to mitigate these effects. Despite the importance of this issue, the United States does not have a significant research program to assess the potential impacts of aviation on climate. This may put the United States at a disadvantage in evaluating technological, operational and policy options, and in negotiating appropriate regulations and standards with other nations. The international concerns will continue to grow with the strong increase in air transportation demand anticipated for Asia."

According to GAO, the emissions trading scheme involves a "cap and trade" system that sets allowances for greenhouse gas emissions for industries and other sources.[5] Parties that pollute below their allowance receive emissions credits, which they can trade in a market to other parties that have exceeded their allowance. As proposed, the EU's scheme would apply to air carriers flying within the EU and to carriers, including U.S. carriers, flying into and out of EU airports in 2012. For example, under the EU proposal, a U.S. airline's emissions in domestic airspace as well as over the high seas would require permits if a flight landed or departed from an EU airport. Airlines whose aircraft emit carbon dioxide at levels exceeding prescribed allowances would be required to reduce their emissions or to purchase additional allowances. According to GAO, although the EU's proposal seeks to include U.S. airlines within the emissions trading scheme, FAA and industry stakeholders have argued that U.S. carriers would not legally be subject to the legislation.

Subcommittee on Space and Aeronautics' March 2007 Hearing On Status and Issues Related to the JPDO and NextGen

During the March 29, 2007 hearing held by the Subcommittee on Space and Aeronautics on the status and issues associated with JPDO and NextGen, Mr. Charles Leader, Director of the JPDO, testified that two fundamental NextGen technologies were just beginning implementation: Automatic Dependence Surveillance Broadcast (ADS–B), and System Wide Information Management (SWIM) and mentioned the near-term release of three important NextGen documents: the Concept of Operations, the Enterprise Architecture, and the Integrated Work Plan. Dr. Gerald Dillingham from GAO discussed the JPDO's organizational structure, technical planning, and research funding. He urged the JPDO to involve all stakeholders, including active traffic controllers and technicians. Mr. John Douglass, then the President and CEO of the Aerospace Industries Association, noted that industry was an essential partner in NextGen and that it is important for industry to have confidence in the government's commitment to NextGen. Dr. Bruce Carmichael, Director, Aviation Applications Program, Research Applications Laboratory, National Center for Atmospheric Research stated that seventy percent of delays in today's

[5] GAO, *Aviation and the Environment: NextGen and Research and Development Are Keys to Reducing Emissions and Their Impact on Health and Climate* (May 2008).

system are attributable to weather and that NextGen will integrate the weather programs of the FAA, DOD and NOAA.

Progress in Completing Key Foundational Documents

At the March 2007 hearing, the JPDO acknowledged that it had been working to establish a Memorandum of Understanding (MOU) between its participating agencies since at least August 2005 but indicated that only two signatures on a draft MOU had been secured to date. Witnesses at that hearing supported the need for a signed MOU, one witness saying that the document needed to be in place to span likely changes in senior management and another witness characterizing the MOU as fundamental, in that without one, the delayed dialogue among entities "is almost impossible to put into any rational context." It was not until June 9, 2008 that the MOU was finally signed by all five agencies.

Three key planning documents were released by the JPDO subsequent to last year's hearing. These documents form the NextGen baseline plan: the Concept of Operations (Version 2.0), released June 13, 2007; the Enterprise Architecture (Version 2.0), released June 22, 2007; and the Integrated Work Plan (Version 0.2), released February 15, 2008. The Research Plan, released August 31, 2007, has since been incorporated into the Integrated Work Plan.

The Concept of Operations document is the most fundamental and explains how the system will work and what it will look like. The JPDO states that this is important in developing the structure, policy, and procedures, and the changes needed to make the system a reality. The Enterprise Architecture document is a highly technical description of the NextGen system. According to the JPDO, it is meant to provide a common tool for planning and understanding the interrelated systems that make up NextGen. As such, the Enterprise Architecture serves as a guide in coordinating R&D activities and developing JPDO's future needs for research and capital investment. The Integrated Work Plan provides the research, policy and regulation, and acquisition timelines necessary to achieve NextGen by 2025.

External Reviews of NextGen and JPDO

There have been several recent independent reviews on the progress of NextGen and JPDO's activities subsequent to the March 2007 hearing held by the Subcommittee on Space and Aeronautics. Some of the key findings and recommendations of those reviews are as follows:

Government Accountability Office

Dr. Gerald Dillingham of the GAO testified on May 9, 2007 before the House Committee on Transportation and Infrastructure's Subcommittee on Aviation [GAO–07–784T] on the status of the NextGen initiative [Dr. Dillingham, one of the hearing witnesses, participated in the study and will be able to provide an update]. Some of the main points made by Dr. Dillingham were as follows:

- *"JPDO has continued to make progress in furthering its key planning documents. JPDO has experienced delays in the release of key documents, but currently plans to have initial versions of these documents released by July 2007. JPDO has been working since 2005 to establish a memorandum of understanding between its partner agencies, although as of May 4, 2007, the memorandum had been signed by the Departments of Transportation and Commerce and NASA, but was not yet signed by the Departments of Defense and Homeland Security."*
- *"FAA and JPDO continue to face a number of challenges in moving toward NextGen, including questions about FAA's technical and contract management expertise; FAA's ability to maintain a number of existing systems, including monitoring and addressing equipment outages to ensure the safety of these existing systems as it transitions to NextGen; and conducting necessary human factors research."*
- *"In addition, while JPDO recently estimated that the total federal cost for NextGen infrastructure through 2025 will range between $15 billion and $22 billion, questions remain about which entities will fund and conduct the necessary research, development, and demonstration projects that will be key to achieving certain NextGen capabilities."*
- *"Also, JPDO faces a continuing challenge in ensuring the involvement of all key stakeholders, such as active air traffic controllers and system technicians, in its NextGen planning efforts."*

In providing answers for the record for that same hearing, GAO responded [GAO–07–928R] to a question from Chairman Costello on the extent to which moving the JPDO out of the FAA's Air Traffic Organization (ATO) would give the JPDO greater visibility and authority, and the potential pluses and minuses of such a move. GAO said:

- *"Currently, JPDO is located within FAA and reports to both the FAA Administrator and the Chief Operating Officer of ATO. In GAO's view, JPDO should not be moved out of FAA."*
- *"However, JPDO's dual reporting status hinders its ability to interact on an equal footing with ATO and the other partner agencies. On one hand, JPDO must counter the perception that it is a proxy for the ATO and, as such, is not able to act as an "honest broker." On the other hand, JPDO must continue to work with ATO and its partner agencies in a partnership in which ATO is the lead implementer of NextGen. Therefore, it is important for JPDO to have some independence from ATO. One change that could begin to address this issue would be to have the JPDO Director report directly to the FAA Administrator. This change may also lessen what some stakeholders now perceive as unnecessary bureaucracy and red tape associated with decision-making and other JPDO and NextGen processes."*
- *"As a part of any change in the dual reporting status of JPDO's Director, consideration could be given to the possibility of creating the position of Associate Administrator of NextGen and elevating the JPDO Director to that post."*
- *"One plus or advantage of moving JPDO out of ATO is that it could raise JPDO's authority and visibility in interagency deliberations by putting JPDO on an equal footing with ATO and other FAA lines of business. For example, moving JPDO out of ATO might strengthen its linkages to the Department of Defense (DOD) and the Department of Homeland Security (DHS). In addition, JPDO may be able to work more effectively with other FAA lines of business, such as Airports, for which JPDO has planning responsibilities. For example, JPDO is responsible for developing plans to increase airport capacity. A minus or disadvantage of moving JPDO out of ATO is that because much of the work related to implementing NextGen must occur under ATO, this work could be harder to accomplish."*

GAO also reported to the Subcommittee on Space and Aeronautics earlier this year on noise and other environmental impacts of aviation that may fundamentally constrain air transportation in the 21st century [GAO–08–384]. GAO said that FAA and NASA have aligned their aviation noise R&D plans through a number of planning and coordinating mechanisms in order to ensure that these plans are complementary and contribute to goals for addressing the environmental impacts of aviation, particularly as these impacts relate to the implementation of NextGen.

Department of Transportation Office of the Inspector General

On April 14, 2008, the DOT's Office of the Inspector General (OIG) released a report [AV–2008–049] on how FAA's air traffic control projects are impacted by plans for NextGen [Mr. Calvin Scovel, DOT's Inspector General and one of the hearing witnesses, participated in the study and will be able to provide additional details]. Some of the main findings and recommendations of the OIG study were as follows:

Findings

- *"Much work remains to determine NextGen's impact on existing projects. FAA is currently exploring ways to accelerate elements of NextGen. FAA faces complex integration issues (linking new and legacy systems) and must manage interdependency among diverse projects. The pace of introducing new automation, more flexible airspace, and data-link communications will be governed by the pace of existing projects."*
- *"Over the next two years, over 23 critical decisions must be made about ongoing programs. These decisions affect major lines of the modernization effort with respect to automation (modernizing terminal and en route capabilities), communications (moving forward with data-link programs), navigation (deciding whether to retain or discontinue certain ground-based systems), and surveillance (using satellite-based and radar information with existing ATC systems)."*
- *"These decisions and many others will depend heavily on the development of a comprehensive Enterprise Architecture (a technical roadmap) that lays out the vision of how the system will work and what changes will be required. The*

Enterprise Architecture must establish a transition path that identifies the role and evolution of current systems and how they will transition to NextGen."

- *"FAA has made progress in developing the NextGen Enterprise Architecture, but planning documents lack details on requirements, particularly for automation, that could be used to develop reliable cost estimates. FAA must revise these documents to prioritize NextGen operational improvements and systems and ensure that these priorities are reflected in NextGen planning documents and budget requests."*
- *"Along with refining the Enterprise Architecture, FAA must chart a clear transition course from the current NAS architecture to the vastly different NextGen environment. Our work shows that FAA needs to conduct a gap analysis between the current system and the NextGen architecture planned for the 2025 timeframe. This will help establish budget priorities, better define requirements, and refine transition plans. In addition, FAA needs to develop an interim architecture or "way-point" that is manageable and executable for what is expected of the NAS by 2015. Until these steps are taken, it will not be possible to determine technical requirements that translate into reliable cost and schedule estimates for existing or future acquisitions."*

Recommendations

- *"Develop and report on a new set of metrics for measuring progress with NextGen initiatives that focus on the delivery of a new capability with respect to enhancing capacity, boosting productivity, or reducing Agency operating costs."*
- *"Complete a gap analysis of the NAS enterprise architecture that closely examines current systems (the "as is") and the planned NextGen enterprise architecture (the "to be") and develop and establish priorities."*
- *"Once the gap analysis is completed, develop an interim architecture that details what can be accomplished in the 2015 timeframe that will allow FAA to more accurately determine costs and other factors required for NextGen."*
- *"Use the interim architecture as the basis for an integrated program plan that establishes an executable program for the NextGen capabilities. This effort should include detailed cost, schedule, requirements, acquisition strategies, risk management, and the supporting organizational structures to execute the integrated program."*

At an exit conference with FAA officials from ATO and JPDO, those officials generally concurred with all of the OIG's recommendations, including the need to establish metrics for measuring progress with NextGen initiatives and develop an interim architecture for NextGen.

National Academies Workshop on Assessing the Research and Development Plan for the Next Generation Air Transportation System

On April 1 and 2, 2008, a workshop was led by the National Academies' National Research Council to gather reactions to the research and development aspects of JPDO's baseline Integrated Work Plan (IWP). The workshop was composed of experts from JPDO, session moderators, members of the workshop organizing committee, and invited guests from government, industry, and academia who were familiar with air traffic management. Although the workshop was not a consensus activity, a number of issues were raised by the participants in the workshop. As indicated in the pre-publication copy of a summary of the workshop, these included:

- *"The issue of a sensed lack of urgency on the part of the JPDO was mentioned most often by workshop participants. There clearly are economic pressures to move quickly and the rest of the international aviation world is moving forward, particularly in Europe. However, the JPDO is still proposing R&D that needs to be done rather than articulating a clear program. "*
- *"A second issue raised by many of the participants was the JPDO's inability to articulate the goals of the NextGen program. The JPDO outlined a large number of excellent research tasks in its presentations, most of which will likely be required to support future U.S. airspace system needs. However, many participants felt that there was a lack of focus on the most important future needs: airspace and airport capacity."*
- *"Tied to the concern about the lack of clearly stated goals is the concern that prioritization of the individual pieces of the program has not been done. It is*

important to consider how best to spend limited research dollars and to determine the likely payoff for particular investments."

- *"During the workshop, several participants expressed concern with the narrow boundaries and inward focus (at FAA and NASA) of the NextGen R&D program. Participants suggested that a number of connections needed to be made or strengthened with other constituents, such as airport authorities, controllers, local communities, industry, DOD, and international organizations."*
- *"Most participants also felt that the IWP [Integrated Work Plan] was not well-structured from the research perspective and stressed that the document should make research priorities clear. However, these and other participants felt that the current draft IWP contains too much unprioritized detail and is not properly detailed to plan what research needs to be done. Further, other participants felt the IWP does not appear to be the most effective way to oversee or manage the research."*
- *"Concerns were raised by many participants that there may not be sufficient resources to enable development of these transition paths. First, it was not clear how the activity is being financed. That is, it was not clear to the participants who is ultimately responsible for paying for the R&D needed to get to implementation of the program."*
- *"The last key issue centered on political difficulties. Foremost among the workshop participants was the concern about the challenge of making difficult (politically charged) decisions. Government agencies tend to be risk-averse, and some participants feel that the lack of decision-making is holding up the JPDO's ability to move forward on NextGen's research needs. A number of specific issues were identified that are difficult, but which participants felt will need to be addressed. For example, some participants raised the question of how to deal with the issue that although manufacturers are willing to invest in changes desired for environmental improvements, airlines are not willing to pay the additional costs; that is, there is an issue of the trade-off between outcome and cost constraints."*

FAA's Proposed Rule on ADS–B

Last October, FAA issued a Notice of Proposed Rule-making (NPRM) regarding the agency's transition plan to the Automatic Dependent Surveillance-Broadcast (ADS–B) system, a key foundation for NextGen. FAA's planned implementation would require installing ADS–B on all aircraft operating in U.S. airspace by 2020. According to media reports, the proposed rule garnered more than 300 comments, some centering on the fact that mandated equipment on board aircraft would provide only the ADS–B "out" service, where signals transmitted out (identification, GPS position, altitude, heading, speed and other data once per second) would be used primarily by the air traffic control system. Pilots would not be provided with information about other traffic around them, a capability available only with ADS–B "in" equipment, the addition of which was not mandated by the proposed rule. Aircraft equipage of ADS–B "in" and cockpit displays was optional. It has been reported that some operators view the mandated equipage as providing them little or no benefit, although they acknowledge improvement to controller provided information.

According to media reports, FAA has asked the Aviation Rule-making Committee (ARC) to perform an NPRM review. Subsequent to the ARC's report and recommendations, FAA will have different options to consider, namely deciding that the NPRM will remain unchanged, modifying it to incorporate some of the committee's recommendations or performing a complete revision of the proposed rule and producing a supplemental NPRM (SNPRM) to replace it. No date has been established for when FAA will announce its choice of option. It is likely that the mandated equipage date for ADS–B will be delayed.

European Air Traffic Modernization and Associated Research and Development Efforts

Last year, the FAA Administrator signed a Memorandum of Understanding with her European counterpart that formalizes cooperation between the NextGen initiative and the "Single European Sky Air Traffic Management Research Programme" or SESAR program, the European equivalent of NextGen. FAA has said that the agency and the European Commission are identifying opportunities and establishing timelines to implement, where appropriate, common, inter-operable, performance-based air traffic management systems and technologies. This coordination, FAA

said, will address policy issues and facilitate global agreement within international standards organizations.

Compatibility of the NextGen system with SESAR and the air traffic modernization efforts being planned elsewhere in the world is very important to U.S. and international air carriers. That is because failure to ensure compatibility could lead to air carriers having to equip their fleets with two sets of communications, navigation, and surveillance systems.

According to FAA, SESAR is conceived as a system that, while smaller in scope and size, has similar air traffic management goals as NextGen. However, FAA has pointed out an important difference in scope between SESAR and NextGen. The agency says that while SESAR focuses almost exclusively on air traffic management, NextGen takes what is called a "curb-to-curb" approach, and includes not only air traffic control, but also airports, airport operations, security and passenger management, and Department of Defense and Department of Homeland Security requirements.

The JPDO recently completed a comparative assessment of the NextGen and SESAR operational concepts. In this paper, JPDO found that:

- *"The vision and "philosophical" perspectives of both concepts are closely aligned. This is to be expected based on the existence of formal cooperative arrangements between the U.S. and Europe. Further, the participation of a wide variety of stakeholders in both the JPDO and SESAR initiatives allowed for significant information sharing and the identification of best practices to be incorporated."*
- *"Probably the most easily recognized difference in the two concepts is the breadth of scope. The NextGen ConOps* [Concept of Operations] *includes a full "curb-to-curb" approach that includes passenger and inter-modal security considerations. These build on the traditional "block-to-block" concepts that are centered on the airspace operations (including environmental considerations). The SESAR ATM Target Concept remains focused on the more traditional airspace elements and recognizes the need to include airport operations for a complete gate-to-gate process description."*
- *"Another area of difference, although not as dramatic, is how weather is considered in the two concepts. In the U.S. National Airspace System, summer convective weather causes a majority of system-wide delays and therefore has been included as a core element of the proposed concept. Weather is recognized in the SESAR ATM Target Concept, but there does not appear to be the same level of focus on infrastructure, prediction, modeling, and planning as appears to be included in the NextGen concept."*

The European Union is also focusing its aeronautics R&D on environmental effects. Under the aegis of its Seventh Framework Programme, the EU's main instrument for funding research over the period 2007 to 2013, the Union will be conducting research on developing technologies to reduce the environmental impact of aviation with the aim of halving the amount of carbon dioxide emitted by air transport, cutting specific emissions of nitrogen oxides by 80 percent and halving perceived noise. The research will address green engine technologies, alternative fuels, novel aircraft/engine configurations, intelligent low-weight structures, improved aerodynamic efficiency, airport operations and air traffic management as well as manufacturing and recycling processes. The "Clean Sky" Joint Technology Initiative will bring together European R&D stakeholders to develop 'green' air vehicle design, engines and systems aimed at minimizing the environmental impact of future air transport systems. This initiative establishes a Europe-wide partnership between industry, universities and research centers, with a total public/private funding of 1.6 billion Euros.

Chairman GORDON. Let me welcome everyone. This is a bit of an unusual day in that we have the 9/11 Pentagon Memorial Service going on right now, and I understand at 3:00 last night they closed that interstate down over there, so we have I am sure lots of staff and friends that were Members that were taking alternate routes, will take a little bit longer, and but I know that we have a variety of staff and Members also that are watching this hearing on TV. And so we want to proceed.

Before we get going today, I want to take care of a few housekeeping details since this will be our last Full Committee hearing for the session. As you may know, this year marks the 50th anniversary of the Science and Technology Committee. In honor of that milestone we have collaborated with the House Historian's Office to produce a history of the Committee, and it is on our desk and will be getting around to our different stakeholders and friends soon. The Historian's Office has been working to standardize the format to best help future researchers and historians, and our history will be the model for the Committees going forward. And so we have provided these copies today.

Secondly, since many Members have expressed interest in attending a Shuttle launch, I want to let you know that the next launch is currently scheduled for Friday, October the 10th, at 12:30 a.m., so coffee will be provided. There is a possibility that Mr. Mollohan at the Appropriations Committee will be taking a CODEL for that launch and that our Members have been asked to join. And if not, if we have enough Members, we will put together a CODEL of our own.

There is also a launch that is currently scheduled for November the 12th that might be a better option for some Members.

Third, I would like to, again, congratulate all the Members of the Committee for the good and constructive work that we have done this year in a very bipartisan way. Today marks the 122nd hearing, and I am sure the, we hear groans going up from the staff because of that, but we have had 122 hearings. We have moved 78 bills and resolutions through the House, 24 of which have become law, and we have several more pending in the Senate that we hope that will become law before this session is over. This is a record that we should all be proud of, and I hope that we can do even better next year.

And I am also very pleased that all of those bills and resolutions came out of this committee on a bipartisan basis. We are in the process now of trying to close the books on this year. We will soon start to look at our agenda for next year, and we want to do it in a collaborative way. We find that if you take good ideas and work together with Democrats and Republicans to build a coalition that you get a much better bill, and we are going to continue that.

Also, for Members' attention I will let you know that we postponed a trip or CODEL to look at some of the nuclear reprocessing that is done in France and that we will try to get that back up again in the spring.

And so that is—oh, I guess the final point I should make is that our Committee volunteered to be the model for the new energy-efficient rooms here on the Capitol Complex. We have finished many of those. As soon as our last Subcommittee hearing is over with

they will come in and finish up this hearing room, and then hopefully by maybe next January or so we want to invite the family and friends, particularly of our staff, to come and see where they spend all their time and to show the rest of Congress how you really can save energy with an energy-efficient office.

And so, finally, in light of the commemorative ceremony that will be taking place on the Capitol steps later this morning, I intend to keep the hearing moving so that we have an adequate opportunity to hear from our witnesses and examine the important issues facing the NextGen Program before Members have to depart for the ceremony at 11:30.

I, therefore, will be brief in my opening remarks, and I will begin by welcoming our witnesses to today's hearing on a very important topic. America's air transportation has long been the envy of the world, and it is an important contributor to the Nation's economic vitality and quality of life.

Yet it is clear that it is a system under stress and needs to change. Congress recognized that fact when it established the Next Generation Air Traffic Transportation System Initiative now known as NextGen in its Vision 100 FAA Reauthorization that was enacted in late 2003. We sought to harness the resources and expertise of FAA, NASA, DOD, Commerce, DHS, and OSTP in a joint effort to transform the Nation's ATC system so that it will be able to handle the anticipated dramatic future increase in travel demand without compromising safety or the environment.

Today's hearing will provide the Committee with the opportunity to review the progress that has been made to date as well as examine the challenges that need to be addressed. We should have no illusions about the magnitude of the task. NextGen is a systems, engineering, management, and regulatory challenge as complex as any the Nation has ever faced. And success is not guaranteed.

Last year we recognized that NextGen has to succeed, recognized that NextGen needs to succeed. This committee and the Transportation and Infrastructure Committee worked together to frame provisions in the House FAA Reauthorization Bill, H.R. 2881, that sought to strengthen the interagency NextGen planning and development effort and to move NextGen R&D into new operational capacities as soon as practicable.

In that regard, I want to salute Chairman Costello of the T&I Aviation Subcommittee for his strong leadership in developing the overall FAA Reauthorization Bill and for the spirit of cooperation he showed to us.

In addition to his T&I responsibility, he is a valued senior Member of this committee, and I look forward to continuing to work collaboratively with him and his staff on these important issues in the next Congress.

Yet we also need for the FAA to work cooperatively with us if we are to fulfill our oversight responsibility with respect to the NextGen initiative. Therefore, it was troubling to find out that the restructuring of the FAA's NextGen Program this summer from news accounts and not from the FAA itself. It was also very troubling to find out that the status of the NextGen Joint Planning and Development Office, JPDO, had been downgraded in the FAA and

restructuring in a move directly counter to the intent of provisions of H.R. 2881.

We need to hear why FAA decided to take such a step in the waning days of the current Administration. And finally, it is troubling that the FAA did not deliver this testimony for today's hearing to the Committee until yesterday afternoon at 3:00, giving us little time to review it. I find that unacceptable, and I hope that we will not see a repeat of any of these practices when it comes to meetings in the 111th Congress.

As my friend Mr. Hall remembers, former Chairman Sensenbrenner dismissed a hearing like this a few years ago because of late testimony. We are not going to do that this time because this is our last hearing, but this is going to be important. This committee is going to do its oversight. We can do it the easy way, or we can do it the hard way, and hopefully we are going to be able to work together next year.

Well, we have a great deal of issues to cover today, so I will close by simply expressing my strong belief that the next President needs to make the NextGen Initiative a national priority and ensure that it is given the resources, management attention, and sense of urgency that it warrants. It is important.

Again, I want to welcome our witnesses, and I look forward to their testimony, and I now recognize Mr. Hall for his opening statement.

[The prepared statement of Chairman Gordon follows:]

PREPARED STATEMENT OF CHAIRMAN BART GORDON

America's air transportation system has long been the envy of the world, and it is an important contributor to the Nation's economic vitality and quality of life.

Yet it is clear that it is a system under stress, and it needs to change.

Congress recognized that fact when it established the Next Generation Air Transportation System initiative—now known as NextGen—in its *Vision 100* FAA Reauthorization that was enacted in late 2003.

We sought to harness the resources and expertise of FAA, NASA, DOD, Commerce, DHS, and OSTP in a joint effort to transform the Nation's ATC system so that it will be able to handle the anticipated dramatic future increases in travel demand without compromising safety or the environment.

Today's hearing will provide this committee with the opportunity to review the progress that has been made to date as well as examine the challenges that need to be addressed.

We should have no illusions about the magnitude of the task—NextGen is a systems engineering, management, and regulatory challenge as complex as any the Nation has ever faced—and success is not guaranteed.

Last year, recognizing that NextGen has to succeed, this committee and the Transportation and Infrastructure Committee worked together to frame provisions in the House's FAA Reauthorization bill—H.R. 2881—that sought to strengthen the interagency NextGen planning and development effort and to move NextGen R&D into new operational capabilities as soon as practicable.

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Well, we have a great many issues to consider today, so I will close by simply expressing my strong belief that the next President needs to make the NextGen initiative a *national priority* and ensure that it is given the resources, management attention, and sense of urgency that it warrants.

It is that important.

Again, I want to welcome our witnesses, and I look forward to your testimony.

Mr. HALL. Mr. Chairman, I thank you, and before I go into my opening statement let me agree wholeheartedly with your opening statement and your outlining the accomplishments of this committee. More than any other committee under the Capitol Dome we have been successful, and we have been successful because we have had good leadership. And I would say this. If all Chairmen have operated like our Chairman has operated, both professional leadership and personal friendship and cooperation, we would have less acrimony and less anxiety every two years as to who is going to have the gavel. He has rendered a very fair gavel, extended friendship, and cooperation, and I think we really ought to give him a good round of applause.

So now I will read my statement. And I thank you for calling today's hearing to review the Federal Aviation Administration's development of the Next Generation Air Transportation System. I also want to extend a sincere thank you to our panel of expert witnesses for taking your time from your busy schedule to appear before the Committee.

The information and advice you provide this committee and Congress will help us better deal with the challenges of modernizing our nation's critically important air traffic management system. Congress passed legislation not quite five years ago calling for the creation of the Joint Planning and Development Office and charged it with planning for and coordinating the research and development of a Next Generation Air Transportation System.

The rationale for Congress' action was clear. Congestion in and around our nation's airports was reaching gridlock, resulting in significant economic losses to carriers, severely inconveniencing large numbers of passengers, and threatening the vitality of our economy. It was estimated that demand for airline services would triple by the year 2025, and absent a more comprehensive and clearly-defined research, development, and implementation program future economic growth would be jeopardized.

Therefore, Congress responded by creating the JPDO to address this serious challenge. Congress clearly recognized that integrating new, automated features into a nationwide network of communications, navigation, and surveillance systems is a huge challenge, and it will take clear and persistent management to achieve NextGen's goals.

We also recognize that the future system must allow for more efficient routings and minimize delays in order to conserve fuel, the cost of which has risen dramatically in the last several months.

Congress was confident then, as we are today, that through the focused leadership of the Federal Aviation Administration, the JPDO, its federal partners, and industry, these challenges will be met.

This is the second oversight hearing in as many years held by this committee regarding NextGen. I also note that during the first session of this Congress our committee produced legislation strengthening the role and visibility of the Joint Planning and Development Office. Sadly, the legislation has been hung up in the Senate.

The Nation's Air Traffic Management System is fundamental to our economy and our quality of life. NextGen absolutely must not be allowed to falter, and it is vitally important that there is accountability both at the FAA and among federal partners, and that roles and responsibilities are clearly articulated. So long as there is clarity in the management of NextGen and a well-understood and sustainable research, development, and implementation program, I am confident that we will succeed.

And Mr. Chairman, I thank you and again, my thanks to the witnesses. I yield back my time.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF REPRESENTATIVE RALPH M. HALL

Mr. Chairman, thank you for calling today's hearing to review the Federal Aviation Administration's development of the Next Generation Air Transportation System. I also want to extend a sincere thank you to our panel of expert witnesses for taking time from their busy schedules to appear before our committee. The information and advice you provide this committee and Congress will help us better deal with the challenges of modernizing our nation's critically important air traffic management system.

Congress passed legislation not quite five years ago calling for the creation of the Joint Planning and Development Office (JPDO) and charged it with planning for, and coordinating the research and development of, a next generation air transportation system. The rationale for Congress' action was clear—congestion in and around our nations' airports was reaching gridlock, resulting in significant economic losses to carriers, severely inconveniencing large numbers of passengers, and threatening the vitality of our economy. It was estimated that demand for airline services would triple by the year 2025, and absent a comprehensive and clearly-defined research, development and implementation program, future economic growth would be jeopardized. Therefore Congress responded by creating the JPDO to address this serious challenge.

Congress clearly recognized that integrating new, automated features into a nationwide network of communications, navigation and surveillance systems, is a huge challenge, and it will take clear and persistent management to achieve NextGen's goals. We also recognize that the future system must allow for more efficient routings and minimize delays in order to conserve fuel, the cost of which has risen dramatically in the last several months. Congress was confident then, as we are today, that through the focused leadership of the Federal Aviation Administration, the JPDO, its federal partners, and industry, these challenges will be met.

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Thank you, Mr. Chairman, and again my thanks to our witnesses for being here today.

Chairman GORDON. Thank you, Mr. Hall. If there are Members who wish to submit additional opening statements, your statement will be added to the record.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Thank you, Mr. Chairman, for holding this hearing today. As the Chairman of the Subcommittee on Aviation, the NextGen system is one that I have worked on for some time.

The goal of this program, when implemented, is to significantly increase the safety, efficiency, and environmental compatibility of air transportation operations. NextGen will move the air transportation system away from the costly ground-based systems that have defined air traffic control for the past fifty years to satellite based technology.

The FAA forecasts that airlines are expected to carry more than one billion passengers by 2015, increasing from approximately 740 million in 2006. The Department of Transportation (DOT) predicts up to a tripling of passengers, operations, and cargo by 2025. While these predictions may be affected by the high cost of fuel, nevertheless this modernization is very much needed, and we must ensure its effective and efficient implementation.

The NextGen plan that is under development will consist of new concepts that rely on satellite-based capabilities; data communications; information and weather capabilities that will support strategic decisions; and enhanced automation. As Chairman of the Aviation Subcommittee and after spending a considerable amount of time on this project, we have learned that the NextGen system must evolve incrementally through sound contract management by the FAA coupled with vigorous Congressional oversight. To that end, today's hearing and the Science Committee's involvement with NextGen can contribute its success.

I have concerns that FAA's restructuring related to NextGen lowers the status of the Joint Planning Development Office (JDPO) and does the complete opposite of what the House directed in H.R. 2881, the FAA Reauthorization bill, which we passed in September 2007. I have also been concerned that under this restructuring, the roles of the JPDO and the Air Traffic Organization are blurred.

I believe we all must work together to ensure we have the resources needed for NextGen to be a success and so that our aviation system continues to be the best in the world.

I want to thank the Chairman for his attention to this issue. I would also like to thank all of our witnesses today for coming and I look forward to the testimony.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman. Because of my service on the Committee on Transportation and Infrastructure, I am particularly interested in the subject of today's Full Committee hearing.

Our air traffic control system is of critical importance to our safety and also to our national security.

In June of 2008, the Dallas Fort Worth International Airport alone moved more than five million passengers. That is in one month, at one airport.

Our skies are crowded with commercial and private aircraft. As air traffic becomes heavier, the technology that manages the load will be under greater pressure to perform without error.

The Federal Aviation Administration must work with the federal science agencies to ensure that the next generation of air traffic control technologies—called NextGen—will be able to accommodate the needs of tomorrow's air traffic.

This wide-ranging transformation of the national air transportation system will move away from long-relied-upon technologies.

It will use more satellite based technology, and it will enable better weather imaging across the entire national airspace system.

The transformation will enable will improve airport surface movements at busy airports such as the one in Dallas. It will reduce spacing and separation requirements of aircraft.

The system will also better manage the overall flows into and out of busy metropolitan airspace to provide maximum use of high demand airports.

NextGen represents the collaborative effort of seven federal organizations, and the planning and implementation of it will be carried out by a unique public/private partnership called the Joint Planning and Development Office (JPDO).

This committee will be interested to know about recent FAA realignment of NextGen activities and changes in the Joint Planning and Development Office.

We want to understand that the reorganization of the project represents a step toward clarity, rather than a tangle of bureaucracy.

The American public deserves to know how and why these decisions are made.

The reorganization of our national air traffic control system technology is no small ordeal. We as Members of this committee are tasked to be stewards of the public's investments.

I want to thank the witnesses who are here today to illuminate matters for us.

Thank you, Mr. Chairman. I yield back.

[The prepared statement of Chairman Udall follows:]

PREPARED STATEMENT OF CHAIRMAN MARK UDALL

I want to thank Chairman Gordon for holding this very timely hearing. It is important that this committee continue to pay close attention to the progress and challenges of the interagency Next Generation Air Transportation System [NextGen] initiative—the national effort to transform the Nation's aging air traffic control system so that it can accommodate the large increases in travel demand forecast to occur over the next two decades. As I have often stated, America's aviation system is vital to the continued health of our economy and our competitiveness in the wider world beyond our shores, as well as being important to our quality of life. We need to ensure that we do all that is necessary to maintain its health.

Last year I chaired a Space and Aeronautics Subcommittee hearing on the Joint Planning and Development Office's progress in planning and coordinating the research necessary to implement NextGen. I opened last year's hearing by saying that I was troubled by indications that all may not be going as well as hoped with the NextGen effort and that we had not yet seen a clear plan from FAA and the JPDO for implementing agreed-upon NextGen technologies and procedures into the National Airspace System expeditiously. As it turns out, we found out during that hearing that long-promised planning documents and a critical interagency Memorandum of Understanding were not yet completed. I am keenly interested in seeing what progress has been made since that hearing.

Today, the need for NextGen is greater than ever. Passengers are faced with incessant delays, many caused by an aging air traffic control system's inability to cope with the capacity-reducing effects of bad weather. Over the short-term, soaring fuel prices have put some airlines on the brink of economic collapse. Over the longer-term, with reduced capital on hand to pay for higher fuel costs, other airlines have postponed purchases of quieter and more fuel efficient aircraft. And just last month, a shutdown of a critical computer system stranded hundreds of aircraft and delayed thousands of passengers. As I said after the incident, the outage demonstrated just how vulnerable our air traffic control system is—and how critical it is to our economic well-being, competitiveness and our quality of life.

Now I want to note that this committee and this House of Representatives have not been standing still. Last September the House passed an FAA reauthorization bill—which included provisions I authored to improve our air traffic control system—by a healthy margin. Unfortunately, that legislation has not yet cleared the Senate. H.R. 2881 addresses critical needs related to NextGen. The R&D provisions in the House-passed bill will help ensure that the Nation's air transportation system is able to handle the expected significant growth in future air travel demand over the next twenty years safely, efficiently, and in an environmentally friendly manner.

It is imperative that the Congress help ensure that FAA has the tools it needs to keep the Nation's air transportation system safe, efficient, and environmentally friendly. With a projected cost to taxpayers as much as $22 billion and to airspace users as much as $20 billion, it is important that we get NextGen right and that those asked to make sizable investments get a viable return. FAA needs to move smartly and in a focused manner, making sure that announced near-term accelerations of regional demonstrations do not detract from the long-term benefits promised nationwide.

I recognize that developing and implementing NextGen are enormous challenges. However, we need to look both at where progress is being made and where improvement is needed. I look forward to reviewing the testimony of today's distinguished panel of witnesses and to getting their constructive suggestions on how we can help make the transition to NextGen a reality.

[The prepared statement of Ms. Richardson follows:]

PREPARED STATEMENT OF REPRESENTATIVE LAURA RICHARDSON

I want to thank Chairman Gordon and Ranking Member Hall for holding this important hearing today, and our witnesses for their appearance. The purpose of today's hearing is to examine the status of the NextGen system and to discuss any issues surrounding the full implementation of this new technology.

At the end of every legislative week I fly home to my district, and I land at LAX, one of the Nation's busiest airports. However, what many travelers are not aware of, are the numerous runway incursions that have occurred this past decade at LAX, 55 since 2001. This number is so alarming that the LA City Council called on us, the Federal Government, to hire more air traffic controllers. Now assigning blame will not reduce the number of incursions, but the implementation of the NextGen system will, so the status of NextGen is important to me. In fact I was commenting yesterday in relation to legislation that we passed in the House Tuesday night, that as Members of Congress our most important duty is to ensure the safety of the American people. We need to maintain the confidence of the American people in our air traffic system.

Aside from the obvious safety issues, the stability of our national economy depends upon a safe, reliable air traffic system. According to the FAA, independent economic studies have estimated that if indirect and secondary impacts are included (such as visitor expenditures and other economic activity generated by aviation) the industry contributes $640 billion to the U.S. economy—or 5.4 percent of U.S. GDP—and over nine million jobs.

More importantly, the simple fact that air travel is expected to increase significantly in the coming years demands that we implement the NextGen system as soon as possible. Based on FAA reports in 2005, 738 million passengers flew on U.S. commercial carriers, compared with 579 million in 1995 and 395 million in 1985. Furthermore the FAA expects this figure to reach one billion passengers by 2015—less than a decade from now. Last summer was a grim reminder of the pain that travelers endure when the air traffic system is pushed to its limits.

It is my understanding that NextGen, which utilizes GPS technology, has been used quite successfully for oceanic operations. Therefore I would like to hear from our witnesses what we can learn from that experience. Likewise I also understand that funding of the NextGen system is still in question. I would like to hear from our witnesses as to how we can achieve a balanced and adequate approach to fund this critical piece of technology.

I look forward to a productive discussion, Mr. Chairman I yield back my time.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Mr. Chairman, thank you for hosting this hearing to examine the status of the Next Generation Air Transportation System (NextGen) initiative and the role of the Joint Planning and Development Office (JPDO) in charge of planning NextGen.

A century ago the Wright brothers revolutionized America by marking the first successful human flight. From the small beginnings of the Wright brothers flying machine, to the Boeing 747s that rule our great skies today, the aviation industry has made leaps and bounds in progress. NextGen offers the next stride in the growing success of aviations effort to become safer and more efficient. As a Member of the Science and Technology Committee, and the Subcommittee on Aviation at the Transportation & Infrastructure Committee, I have a vested interest in this issue.

NextGen offers many exciting possibilities for aviation. The National Airspace System (NAS) has become operationally obsolete, reached increased capacity levels and been affected by high oil prices. NextGen could offer the possibility of capacity relief, a curb in carbon dioxide emissions, and a significant economic growth in the industry. I am looking forward to learning more about the progress being made by JPDO, and hope the promise that NextGen offers to the aviation field and the Nation can become a reality.

I would like to thank today's witnesses; Ms. Cox, Dr. Dillingham, Mr. Scovel, Dr. Kaminski, and Professor Waitz for taking the time to appear before us. I look forward to hearing your testimonies.

[The prepared statement of Mr. Mitchell follows:]

PREPARED STATEMENT OF REPRESENTATIVE HARRY E. MITCHELL

Thank you, Mr. Chairman.

Today we will examine the status of the Next Generation Air Transportation System (NextGen) initiative.

As demand for air travel continues to grow, and we search for ways to expand capacity, the deployment of new technology like NextGen is going to play an important part.

The need for additional capacity is especially acute in the Phoenix metropolitan area. Sky Harbor Airport is already the Nation's eighth busiest, and the Federal Aviation Administration has already warned the Valley that it will need additional capacity to meet the expected increase in demand.

Fortunately, the City Of Phoenix is joining other Valley communities to develop Phoenix–Mesa Gateway Airport on the site of the former Williams Air Force Base in Mesa.

Just this week we learned that Gateway, while still in its infancy as a potential reliever for Phoenix Sky Harbor International Airport has an estimated economic impact that has grown to $500 million a year and supports more than 4,500 local jobs, according to a study by Arizona State University.

I look forward to today's hearing. At this time I yield back.

Chairman GORDON. At this time I would like to introduce our panel of witnesses today. First, we have Ms. Victoria Cox, the Senior Vice President for NextGen and Operations Planning in the Air Traffic Organization of the Federal Aviation Administration, Dr. Gerald Dillingham, who is a Director of Physical Infrastructure Issues at the Government Accountability Office, the Honorable Calvin Scovel, III, who is the Inspector General of the U.S. Department of Transportation, Dr. Paul Kaminski, who is the Chairman and CEO of——

Dr. KAMINSKI. Technovation.

Chairman GORDON. Technovation, and Dr. Ian Waitz, who is the Director of the FAA- and NASA-sponsored Center of Excellence PARTNER and the Head of the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology.

Welcome all. And as our witnesses should know, spoken testimony is limited to five minutes each, after which the Members of the Committee will have five minutes each to ask questions, and we will start with you, Ms. Cox.

STATEMENT OF MS. VICTORIA COX, SENIOR VICE PRESIDENT FOR NEXTGEN AND OPERATIONS PLANNING, AIR TRAFFIC ORGANIZATION, FEDERAL AVIATION ADMINISTRATION

Ms. COX. Good morning, Chairman Gordon. Thank you. It is a pleasure to address you and Congressman Hall and Members of this committee. I am Victoria Cox, the FAA's Senior Vice President for NextGen and Operations Planning.

Congress has been direct in its charge to the FAA; improve the level of safety, security, efficiency, quality, and affordability of the Air Transportation System and reduce the production of noise and emissions.

We are following that guidance as we develop and deploy the Next Generation Air Transportation System. NextGen will apply the same precision, automation, and access to information to aviation that already exists in other industries and in our daily lives. We can deliver it, and we intend to deliver first in the places that need it most. We are accelerating our efforts with focused deployment of NextGen precision aviation capabilities around our most

congested airports. We are fostering partnerships with operators equipped to perform precision navigation procedures.

These efforts are yielding big benefits and lessons learned, but the real punch comes in the form of immediate reductions to delays, fuel use, and emissions. We are still not where we want to be, but we are making progress.

One of the early successes is the Atlantic Inter-operability Initiative to Reduce Emissions or AIRE. It is a research and technology development venture among the FAA, the European Commission, and industry partners. It upgrades air traffic control standards and procedures in trans-Atlantic flights.

When you make even small changes in fuel use on flights that are typically several hours long and cover thousands of miles, the results are dramatic. We have already seen a fuel savings of one percent in oceanic airspace. A typical oceanic flight might burn 13,000 gallons. Multiply that by the number of flights over the course of a year, and one percent is a lot of fuel saved and a lot of emissions reduced.

We are planning similar demonstrations in the South Pacific. In fact, the first of three demonstration flights will occur tomorrow from New Zealand to San Francisco.

We are using NextGen technology to make things more efficient on the ground as well. We are introducing state-of-the-art surface management tools at JFK. These are based on Airport Surface Detection Equipment Model X or ASDE–X. Last summer at JFK a plane that had been holding on a ramp for hours might not have had an option to turn back to the gate readily because no one, not the airline and not air traffic control, had a common picture of where all other aircraft were located on the ramps and at the gates. As of last month much-needed information about aircraft location is available to airlines, controllers, and to FAA's command center in Herndon, Virginia.

Service operations are no longer a black hole at JFK. Delta Airlines is already using this capability. This JFK initiative stems from a joint FAA, NASA research and development project in Memphis with Fed Ex and Northwest Airlines. With this capability Northwest has significantly improved their operations, lowered fuel consumption, and cut emissions.

Progress is being made, but we know that NextGen implementation is a difficult and complex undertaking. And while it cannot be accomplished without cooperation across the entire FAA and the NextGen partner agencies, we understand that there must be a single point of accountability. To that end the FAA established the position of Senior Vice President for NextGen and Operations Planning. In that position I am directly responsible and accountable for all elements of NextGen and have decision authority over all matters related to NextGen integration and implementation in the FAA.

The establishment of this office places the Joint Planning and Development Office, the Legacy Operations planning function, and the new office of NextGen Integration and Implementation under a common reporting structure. This restructuring is an indication of the changing focus of NextGen from purely planning and research to actual integration and implementation capabilities that

will transform the National Airspace System. And it is also a recognition of the fact that implementation must occur in the operational environment.

We are not losing sight of the future NextGen vision. Our Joint Planning and Development Office will continue to focus on long-term R&D and on cross agency cooperation. The FAA is placing its emphasis on near-term implementation and mid-term planning over a rolling 10-year timeframe.

Given the impact on aviation, of aviation on the U.S. economy and the long-standing support from this committee, this Congress, and most of the aviation community, I sincerely believe that the impetus for NextGen and its program focus will continue and not suffer as transitions occur.

In closing, I want to thank both this Administration and this Congress for supporting the FAA's NextGen budget request. Mr. Chairman, this concludes my testimony, and I would be happy to answer any questions the Committee may have.

[The prepared statement of Ms. Cox follows:]

PREPARED STATEMENT OF VICTORIA COX

Good morning, Chairman Gordon, Congressman Hall, and Members of the Committee. I am Victoria Cox, Senior Vice-President for NextGen and Operations Planning in the Air Traffic Organization at the Federal Aviation Administration. I thank you for the opportunity to testify today about the status of the work we are doing to develop and deploy the Next Generation Air Transportation System (NextGen) and to discuss how we are providing operational, environmental, and safety enhancements that deliver benefits to our customers today and into the future.

As you know, NextGen is not a single capability or program to be delivered at some date in the future; it is a portfolio of capabilities and programs that we are beginning to deliver now—and will continue to provide in an evolutionary manner. It is also important to remember that NextGen is not simply about air traffic capabilities, but fostering improvements in ground infrastructure, aircraft technology, and alternative fuels.

Much progress has been made during the past year. We have moved to accelerate initiatives that yield benefits to stakeholders in the near- and mid-term. We have also taken steps to ensure a more holistic approach to managing NextGen and related legacy programs. Last spring, the Secretary of Transportation and the NextGen Senior Policy Committee, which was established by Public Law 108–176 (*Vision 100*) and is chaired by Secretary Peters, asked us to take immediate action to accelerate the deployment of NextGen. In response to this call, the FAA and the other NextGen agencies have focused on accelerating deployment of operational improvements to address the greatest need and on developing the capabilities that will provide the greatest benefit. FAA has leveraged its research and development investments to accelerate targeted implementations and development of critical capabilities.

The introduction and wide-spread use of precision navigation tools that deliver increased precision to our operations represent the first step in our transition to NextGen. We are focusing deployment of Area Navigation (RNAV) and Required Navigation Performance (RNP) around our most congested airports, using these tools to increase capacity and operational efficiency. Partnerships with operators equipped to perform these procedures are yielding the biggest benefits from increases in operational efficiency and reductions in fuel use and emissions. Today, 87 percent of commercial operators are equipped to fly RNAV routes and procedures; and 39 percent are equipped to fly the RNP Special Aircraft and Aircrew Authorization Required (SAAAR) approaches that allow design of flight paths to achieve more optimal use of airspace. FAA has approved these types of approaches at Atlanta, Dallas/Fort Worth, Newark, Washington Dulles, LaGuardia, Chicago Midway, Miami, and San Francisco. To date this year, we have published 20 RNP SAAAR approach procedures at eight airports, including San Jose, Washington Reagan National, Indianapolis and Los Angeles. We have also published 63 RNAV Standard Instrument Departure (SID) and Standard Terminal Arrival (STAR) procedures at 45 airports, including Atlanta, Charlotte, Cincinnati, Newark, Orlando, Phoenix, Portland (OR), Santa Monica and Tucson.

We are also seeing benefits today from the introduction of Optimized Profile Descents or OPD. The OPD lets pilots use the Continuous Descent Arrival (CDA) technique to fly a continuous descent path, rather than the traditional "step downs" typically flown today. Airplanes initiate descent from a high altitude with engines at low power and, ideally, maintain a continuous descent until cleared to land. Flight demonstrations at Louisville's Standiford Airport and testing at Atlanta Hartsfield have shown fuel savings averaging about 50–60 gallons of fuel for the arrival portion of flights and a reduction of as much as 1,200 pounds of carbon dioxide per arrival. Significant noise reduction is also achieved through the later deployment of flaps and landing gear allowed by the CDA's gradual reduction in speed. Under its NextGen Demonstration program, FAA is continuing with targeted implementations of Optimized Profile Descent procedures at San Diego in addition to Atlanta and is cooperating with the United States Air Force Air Mobility Command to introduce OPD procedures with its C17 fleet in Charleston, SC. OPD procedures have been instituted in Los Angeles on a permanent basis and are delivering major benefits in terms of operational efficiency and the environment.

Another NextGen-related demonstration program is the Atlantic Inter-operability Initiative to Reduce Emissions (AIRE), a research and technology development venture between FAA, the European Commission and industry partners. AIRE focuses on up-grading air traffic control standards and procedures for trans-Atlantic flights. A similar initiative in the Asia-Pacific region, the Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) has also been initiated. In fact, tomorrow Air New Zealand is operating a flight, nicknamed ASPIRE I, from Auckland to San Francisco that will demonstrate some of the potential efficiencies. Our Vice President for Enroute and Oceanic Services will be on-board. Both of these initiatives will enhance fuel efficiency while reducing environmental impacts. Our first AIRE demonstrations showed one percent fuel savings in oceanic airspace—a significant amount of fuel and carbon emissions for these very long flights.

Other near-term benefits stemming from targeted implementations of the NextGen acceleration initiative include the introduction of surface management tools at JFK with the accelerated introduction of the Airport Surface Detection Equipment—Model X (ASDE–X). FAA, in partnership with the Port Authority of New York and New Jersey and airlines, is providing information about surface traffic in both movement and ramp areas on the airport to Airline Operation Centers, air traffic controllers and the FAA Command Center. This information gives common situational awareness that will allow airlines to better manage movement of their aircraft in crowded ramp areas. The inability for airlines to know the exact location of their aircraft on the surface relative to other traffic contributes to surface gridlock and difficulty moving aircraft back to gates when required. As of last month, this much-needed information is available.

This capability stems from a joint FAA/NASA research and development project at Memphis with FedEx and Northwest Airlines. The Memphis project is developing a surface traffic management system that employs a two-way, collaborative environment between the FAA and airlines to significantly improve the efficiency of ground operations and will be integrated with arrival and departure traffic to enable the most efficient use of airport and terminal facilities and reduce emissions that impact air quality.

These and other demonstrations are providing valuable information that will assist FAA in developing standards and procedures for operations in the NextGen environment while providing immediate benefits to targeted areas. FAA plans to continue these activities in an integrated test bed approach that focuses on Florida, the east coast, Texas, and the Gulf of Mexico and takes advantage of early Automatic Dependent Surveillance-Broadcast (ADS–B) deployment. Upcoming demonstrations include tailored arrivals in Miami starting later this month with American Airlines and with Air France. We will also begin integrating predictive weather information as part of the Traffic Management Advisor (TMA) at Daytona Beach with Embry Riddle and a consortium of companies in November. We have over 20 partners from the airlines, industry, academia, and other government agencies that are involved in demonstrating the effectiveness and safety of integrated NextGen capabilities. We will model these and another demonstration in ways that enable more rapid, widespread deployment of these capabilities in the future.

NextGen will bring major changes to the roles and responsibilities of all the participants in the NAS, especially the controller, as the NAS becomes more automated and some tasks are delegated to the pilots flying more sophisticated aircraft. A strategic job analysis has been initiated to examine how changes to technology, roles, responsibilities and procedures will impact the aptitudes, knowledge, skills and abilities that we will expect from controllers as NextGen matures. This will enable

the NAS to go from a "controlled" airspace environment to a "managed" airspace environment, allowing automation to assist with decision-making.

The human factors research program has also delivered products that enable the use of data communications in the en route domain and is now focused on the increased use of RNAV, limited self spacing, and novel modes of grouping aircraft to enable an increase in capacity while reducing controller workload and error potential.

Another key NextGen transformation is the move from Forensic Safety Systems to Prognostic Safety Systems, as evidenced by the development of the Aviation Safety and Information Analysis and Sharing (ASIAS) system. The ASIAS program integrates a large number of previously unrelated data sources from both government and industry into a comprehensive safety picture that can assist in identifying emerging risks and enabling earlier interventions against these risks before they can lead to accidents.

Research and development in the weather arena is providing advanced weather capabilities to improve NAS operations during adverse conditions. This requires improvements in weather forecasting and observation network capabilities as well as integration of weather into decision support tools. Improvements in forecasts and observations quality developed by the Aviation Weather Research Program (AWRP) are aimed at providing more accurate aviation weather forecasts for phenomena such as turbulence, convective activity, icing, and restrictions to visibility. The Weather Technology in the Cockpit (WTIC) program will facilitate the development of technologies necessary to integrate weather information into aircraft-based decision support systems. WTIC will enable pilots to access weather information similar to that being utilized by air traffic controllers and dispatchers on the ground.

In Fiscal Year 2008, the wake turbulence research program completed prototype evaluations of the Wake Turbulence Mitigation for Departures tool, a product of NASA and FAA research and development, that permits increased departure capacity from airports with closely spaced parallel runways. Prototype evaluations of the system were conducted at Houston Intercontinental and Lambert St. Louis airports. Another application of research and development has been wake turbulence data collection and analysis in support of a National Rule Change which would allow the use of ILS procedures to Closely Spaced Runways for specific aircraft types, thus increasing capacity at five specific airports.

The wake program, along with global partners, has evaluated separation standards for new aircraft (B–747–8, A380) and has re-evaluated the B757 family of aircraft. We have also developed a methodology and optimization tools for the re-evaluation of wake turbulence categories and separation standards for today's aircraft fleet mix, which has changed significantly since the early 1990's. Working jointly with European Air Navigation Service Providers and aircraft manufacturers, FAA is seeking a harmonized set of wake categories and wake separation minima for the NAS and International fleet mixes.

In an example of concept validation that shows great promise, FAA researchers are developing the concept for an Integrated Arrival/Departure Control Service that we are calling "Big Airspace." Employing modeling and simulation, including human-in-the-loop simulations, researchers used scenarios that incorporated a generic large metropolitan area, a major airport and three small airports into the same Terminal Radar Approach Control (TRACON) facility. The "Big Airspace" concept extends terminal procedures to a portion of en route transition airspace, increasing the number of RNAV routes, and incorporating dynamic resectorization (a fundamental NextGen concept) to allow airspace boundaries to be more flexible. A key element of "Big Airspace" is the incorporation of all operations into one facility to reduce the amount of cross-facility coordination needed to safely manage traffic into and out of busy areas. Human-in-the-Loop simulations employed both terminal and en route controllers as well as pilots who flew simulated aircraft linked to the simulation. Results of the modeling and these simulations showed that controllers could handle up to 50 percent more traffic. With the introduction of data communications, controllers may handle up to 150 percent more traffic before performance degraded, all without a significant change in the number of operational errors and with a significant decrease in the number of conflicts.

With 2012 projected traffic, "Big Airspace" simulations showed increased operational efficiencies of about a minute of flight time and five nautical miles in scenarios with weather present. To provide context for these savings, Southwest Airlines has indicated that for its operations a single minute of time saved on each flight contributes an annual savings of up to $25 million in fuel per year. Extend this to the number of flights operated by all carriers in major metropolitan areas and you can see that "Big Airspace" adds up to tremendous savings for all our air-

lines. FAA is building towards implementing "Big Airspace" as its mid-term concept in high density metropolitan areas.

Accelerating air traffic management improvements is leading to efficiencies and reducing fuel burn, but we are also pursuing other R&D strategies to mitigate NextGen environmental impacts. We are hastening the development of promising environmental improvements in aircraft technology. The President's budget funds a research consortium called Continuous Low Emissions, Energy and Noise (CLEEN) which will allow us to work with industry to accelerate the maturation of technology that will lower energy, emissions and noise. CLEEN offers a good example of FAA and NASA partnership in advancing the NextGen plan as we worked together closely in developing this initiative to mature technology with NASA's foundational research efforts.

We are also exploring the potential of alternative fuels for aviation. Fuels that improve emissions performance at both the local and global level not only help the environment, but also enhance energy security and supplies. Issues of fuel supply and costs are having an increasing impact on the shape of the U.S. aviation system—as fuel costs now approach up to 40 percent of airline operating costs. To this end, the FAA helped form—and is an active participant in—the Commercial Aviation Alternative Fuels Initiative, or CAAFI. We have already seen coal-to-liquid and gas-to-liquid fuels in jets, and most recently completed a bio-fuel flight demonstration. Alternative fuels will be the "game changer" technology that gets us closer to carbon neutrality. Alternative fuels are a part of the CLEEN effort.

Activities like these that consist of concept validation employing modeling and simulation, prototyping and field demonstrations in an operational environment can accelerate the transition from concepts and research and development to implementation of operational systems. FAA is employing this approach in an effort to accelerate NextGen implementation. Not only will this approach speed the development of NextGen operational improvements, it is also aimed at speeding their acquisition by accomplishing, in parallel, required steps in FAA's Acquisition Management System.

Another way that FAA is accelerating transition from research to implementation is through Research Transition Teams (RTT) between NASA and FAA, facilitated by the JPDO. The goal of the RTTs is to ensure that R&D needed for NextGen implementation is identified, conducted, and effectively transitioned to the implementing agency. Four teams are successfully underway with NASA and FAA engagement.

The approaches described above are mechanisms we have established to ensure that we retain the focus on the goals of NextGen while moving expeditiously to incorporate changes into the National Airspace System which support those goals and begin to achieve the benefits of a transformed system in a timely manner.

This year has seen a shift in focus for NextGen from planning to action. The realignment of responsibilities for NextGen under a Senior Vice President for NextGen and Operations Planning is an indication of that changing focus of NextGen from purely planning and research to actual implementation and integration of technologies that will transform the National Airspace System. As we enter this new phase, the Agency decided to place accountability for all aspects of NextGen, including management of the NextGen investment portfolio, under one senior official.

This realignment also responds to stakeholder requests for a single point of accountability for NextGen and addresses the suggestion raised by Industry, including members of JPDO Working Groups, that more focused oversight by FAA of JPDO deliverables would be desirable.

With the establishment of the NextGen and Operations Planning organization under the leadership of a Senior Vice President, the Joint Planning and Development Office (JPDO), the Operations Planning function, and the new Office of NextGen Integration and Implementation have a common reporting structure. For the FAA this ensures that the Agency acts promptly to achieve the JPDO vision by accomplishing the right kind of R&D and that a steady stream of improvements taking us along the road to NextGen are delivered for implementation and coordination with legacy systems operations. This arrangement increases FAA support for JPDO Working Groups as well as cross-agency initiatives by closer linking of FAA to JPDO.

The Senior Vice President for NextGen and Operations Planning is responsible for implementation of all elements of NextGen, most of which are executed by other service units in the Air Traffic Organization and other lines of business in the FAA, and has decision authority over all matters related to NextGen integration and implementation including allocation within the Agency of the $688 million NextGen budget request for fiscal year 2009.

NextGen implementation is a difficult and complex undertaking that cannot be accomplished without cooperation across the industry, the FAA and the NextGen partner agencies. The Senior Vice President for NextGen and Operations Planning has a direct and immediate path to the FAA Administrator and the Secretary of Transportation should their assistance be required.

The highly successful FAA-wide Operational Evolution Plan (OEP) process is the basis for guiding NextGen integration and implementation and ensuring the cooperation of all elements within the FAA with NextGen responsibilities. This process includes all FAA organizations, within and outside of the ATO including the JPDO. The process tracks specific capability improvements through R&D, field demonstration, investment decision, acquisition and implementation, with clear objectives that result in specific commitments to the operating community outside FAA. An executive oversight board (NextGen Management Board) at the Associate Administrator level, chaired by the Deputy Administrator, oversees the process. A review board (NextGen Review Board) manages the flow of improvements from concept, through R&D, to investment decision, to implementation. Aviation community participation will be improved through a formal advisory process, Industry Days, and stepping up stakeholder participation at the SPC, which encourage feedback from users, operators, and developers.

An important product of the process described above is the NextGen Implementation Plan, the latest version of which was published on June 30, 2008. The plan details implementation commitments for the near-term (between 2009–2011), and describes more than 30 additional improvements targeted for introduction between 2012 and 2018. This version shows how FY09 research and development projects move us toward specific outcomes. The entire plan can be accessed on line at *www.faa.gov/nextgen*.

As directed by the Secretary of Transportation, who is Chair of the NextGen SPC, JPDO will continue to focus on long-term (beyond 10 years) research and development and cross-agency coordination with FAA placing emphasis on near-term implementation and mid-term planning over a rolling 10 year timeframe. FAA will ensure that the Agency's implementation plans and Integrated Work Plan are aligned for the near and mid-term, while keeping an eye to the future that JPDO is defining through the long-term R&D plan. The JPDO Integrated Work Plan (IWP), will also be published this month, is still a work in progress, and the elements in it have not yet been prioritized. That said, it represents a great amount of work across the NextGen agencies and industry to document their initial development work and planning.

An overarching goal, and a clear responsibility of JPDO, is a long-term R&D program, with well-defined and prioritized research goals and supporting activities and that responsibility will be clearly assigned to the Partner agencies. Success will depend on assuring that agency R&D budgets are linked. Research must be aligned to leverage cross-agency investments and deliver products that will transition to implementation.

We are confident that planned investments lead to the capabilities described out to 2018. These are investments in the five transformational programs discussed later, as well as to seven solution sets. In total, they fund research, engineering, analysis, demonstrations, concept validation and ATC infrastructure enhancements. The far-term, beyond 2018, is dependent on research that is ongoing or planned in coordination with the JPDO. The results of that research will be used to guide the far-term development. JPDO will continue to maintain the vision of NextGen and will update the Concept of Operations in accordance with results of the long-term research that it is charting.

JPDO will also continue to produce a yearly Progress Report. This year's progress has been noteworthy. The Senior Policy Committee (SPC), chaired by the Secretary of Transportation, provides directed focus on important efforts including a government-wide Safety Management System; a collaborative weather initiative involving the Department of Commerce (DOC), FAA and the Department of Defense (DOD); an initiative for net-centric aviation information sharing; and planning for integrated aviation surveillance with the DOD, Department of Homeland Security (DHS) and FAA.

JPDO has formalized organizational relationships with partners to facilitate transfer of technology for NextGen application by establishing the previously described Research Transition Teams to facilitate smooth transition of research products from NASA to FAA. Additionally, the DOD has established a NextGen Joint Planning Office with the U.S. Air Force leading to coordinated DOD contributions and technology transfer. The DOD, DHS and FAA also jointly invested in a demonstration of Network Enabled Operations technology.

JPDO completed a gap analysis of NextGen partner agency programs against the Integrated Work Plan. The gap analysis identified seven critical interagency focus areas, including various ATM research topics, research to mitigate environmental constraints, security risk management, and the verification and validation of complex systems. FAA was identified as the lead for three of the focus areas, NASA for two, DHS for one, and JPDO for one. Working with the partner agencies, the JPDO will incorporate operational improvements that address these gaps into the Integrated Work Plan and through the governance process, including the JPDO Board and SPC, will encourage partner agencies to include activities that support these operational improvements in their implementation plans and future year budgets.

As we move forward with NextGen it is important for us to measure our progress by defining our near-term, mid-term, and long-term goals with suitable performance metrics. The right metrics will allow us to determine not only how well we are doing but also the impacts of events that reduce or delay progress. FAA plans to employ three methods of measurement. First, we will track progress against milestones established in the NextGen Implementation Plan. These are linked directly to the National Airspace System Enterprise Architecture decision points. We will also track investments, measuring whether specified products are delivered on time and on budget. We are also developing methods to measure and report on benefits accrued with the implementation of NextGen capabilities in an integrated fashion rather than the case by case approach that we take today.

The FAA's National Aviation Research Plan (NARP) published in February 2008 identifies $740 Million for NextGen R&D in the President's Fiscal Year 2009–2013 budget with $83.5 Million requested in Fiscal Year 2009. Much of the other R&D work contained in the 2009 request is NextGen enabling.

My testimony has focused on R&D, Advanced Technology Development and Prototyping and Demonstration investments. Major NextGen transformational programs are making progress as well. ADS–B has continued to meet all the program milestones. Since the national contract was awarded last summer, the program has deployed the ground infrastructure in the Southern Florida key site area. The system has for the first time equipped pilots to receive traffic and weather in the cockpit for enhanced situational awareness. The system will reach an In Service Decision (ISD) for essential services for commissioning into the National Airspace System (NAS) in November 2008. Critical services IOC and ISD is planned for 2010.

While the agency has been busy with deploying the ground equipment, we are also simultaneously working on the rule-making for ADS–B. The Notice of Proposed Rule-making (NPRM) was published in October 2007. The comment period closed in March 2008 and the agency is taking into account every single comment that was received. We have been working closely with all facets of the aviation community through the ADS–B Aviation Rule-making Committee (ARC). We will consider all the recommendations from the aviation community in developing the final rule, which we estimate will be published in spring 2010.

The System-Wide Information (SWIM) Program recently awarded a $37M contract for commercial, off-the-shelf (COTS) software to Iona Technologies of Waltham, Massachusetts. This software will help FAA develop interfaces between systems more quickly and cheaply, and will help establish new connections between systems and with new users—just what's needed for NextGen.

The Data Communications program and the NAS Voice Switch program have both completed development of initial program requirements, and the NextGen Network Enabled Weather (NNEW) program has begun analysis to develop standards for universal access to a weather data base, which will contain forecast information of interest to all national airspace participants including FAA, Department of Defense, National Weather Service and our European partners.

I thank both this Administration and this Congress for supporting the FAA's NextGen budget requests and hope that issues surrounding the FAA's reauthorization are quickly resolved. Be assured that we will identify NextGen as a key programmatic and budgetary issue requiring decisions from policy-makers in the incoming Administration.

Given the impact of aviation on the U.S. economy and the longstanding support from this committee, this Congress, and most of the aviation community, I sincerely believe that the impetus for NextGen and its program focus will continue and not suffer due to transition activities.

Mr. Chairman, this concludes my testimony. I would be happy to answer any questions the Committee may have.

BIOGRAPHY FOR VICTORIA COX

Vicki Cox was named the Air Traffic Organization's Senior Vice President for NextGen and Operations Planning in May 2008. She will serve as the FAA's focal point for the Next Generation Air Transportation System (NextGen), working across all lines of business to lead the transformation of the national airspace system using state of the art technologies to meet changing aviation demands.

Cox previously served as the ATO's Vice President for Operations Planning since 2006, focusing on moving NextGen forward. She joined the FAA in 2003 as Program Director of the Aviation Research Division, where she made an immediate impact working on the Program Assessment Rating Tool (PART) that the Office of Management and Budget requires to assess and improve program performance. Cox then moved to Director of Flight Services Finance and Planning before heading the ATO's International Office.

Prior to joining the FAA, Cox worked for the Department of Defense where she served as Director of International Technology Programs in the Office of the Director of Defense Research and Engineering. She has an extensive research and development and program management background, having supported the Deputy Under Secretary of Defense for Science and Technology as the DOD Laboratory Liaison to the Office of the Secretary of Defense. She also worked as a Program Manager for a number of ballistic missile defense technology programs for the U.S. Air Force.

A physicist, Cox served as Chief of Physics and Scientific Director of the European Office of Aerospace Research and Development in London. She also worked as a scientist responsible for thermal vacuum conditioning and testing of the Hubble Telescope for NASA.

Cox graduated from Converse College and received a Master's degree from East Carolina University. She has a certificate in U.S. National Security Policy from Georgetown University and is a DOD Level III Certified Acquisition Professional in Systems Planning, Research, Development and Engineering. She also earned her private pilot's license in 1985.

Chairman GORDON. Thank you. Dr. Dillingham.

STATEMENT OF DR. GERALD L. DILLINGHAM, DIRECTOR, PHYSICAL INFRASTRUCTURE ISSUES, GOVERNMENT ACCOUNTABILITY OFFICE

Dr. DILLINGHAM. Thank you, Mr. Chairman, Chairman Costello, Members of the Committee. I appreciate the opportunity to discuss the findings of the study that we undertook at your request [*see Appendix 2: Additional Material for the Record*] and respond to your questions about NextGen planning, research and development activities. I will also identify some challenges that I believe must be overcome to implement NextGen.

The stakeholders I refer to in my statement are the 25 aviation industry representatives we interviewed for our study before the ATO was reorganized this past June. They include avionics, aircraft, and ATC equipment manufacturers, ATC system users, and ATC system operators.

I want to note that in contrast to last year when we testified before this committee, active air traffic controllers are now beginning to be participants in the NextGen activities.

However, the safety technicians who will be involved in installing and maintaining NextGen systems have yet to become active stakeholders.

You asked us about the status and usefulness of three key NextGen planning documents. A majority of the stakeholders told us that these documents were of limited usefulness. They said the documents provide high-level views of NextGen benefits but do not include specific details or a structured plan for achieving tangible results.

However, our review of the JPDO's next version of the Work Plan shows progress in providing this kind of information and could make it more useful for monitoring and the oversight of NextGen.

You asked us about the availability of R&D for NextGen planning and implementation. We found that steps have been taken to address some of the initial concerns about the so-called R&D gap that resulted from changes in NASA's research emphasis and the expanding requirements of NextGen.

As you know, the budget request for FAA has increased, which will provide the needed R&D funding for NextGen. JPDO, FAA, and NASA have also begun to move from proposing research to articulating a defined and prioritized R&D program using mechanisms such as the research transition teams.

However, even if FAA's funding increases, some stakeholders question whether the agency has the R&D infrastructure, including the facilities and personnel, to adequately address NextGen's developmental research needs.

Another of your questions related to the JPDO's capacity to coordinate the efforts of partner agencies and act as an honest broker. Since the recent reorganization, JPDO is no longer a separate, independent office within FAA and no longer reports directly to FAA's top management. Instead, JPDO is a part of ATO, reports to the Senior Vice President of NextGen, who in turn reports to the ATO Chief Operation Officer. It is still too soon to know if this governance structure will sufficiently address stakeholders' concerns about NextGen's leadership.

Under an alternative governance structure that is included in the House FAA Reauthorization Bill, the Director of JPDO would be elevated to the Associate Administrator of NextGen, reporting directly to the Administrator. We believe this proposal comes closer to addressing concerns raised by stakeholders than ATO's action and could result in another reorganization and governance structure with the passage of a reauthorization bill.

However, according to an FAA senior executive, the internal FAA stakeholders are knowledgeable about and supportive of the new governance structure. We have suggested that FAA consider a focused outreach and education initiatives to ensure that external stakeholders also buy in and support the reorganization and new governance structure.

Mr. Chairman and Members of the Committee, in closing I would like to briefly turn to what I consider the other key challenges to NextGen implementation. First, to fully realize NextGen capabilities, a new configuration of ATC infrastructure will be needed. This means that FAA needs to give priority to developing a comprehensive facility consolidation and realignment plan.

In addition, airports will need to have increased capacity. NextGen technologies and procedures will enhance capacity, but additions to currently-planned runway construction will be necessary to handle the expected increase in traffic. Runway construction can be a very long and contentious process.

The final challenge remains for Congress. Strong Congressional support will be needed to advance a facility realignment proposal that may include closing or consolidating some individual facilities

to streamline the entire system. And Congress will be challenged to quickly pass a reauthorization bill for FAA, confirm an FAA Administrator and a new Secretary of Transportation. Stable leadership at the top and adequate funding are necessary for the success of NextGen.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Dillingham follows:]

PREPARED STATEMENT OF GERALD L. DILLINGHAM

Mr. Chairman and Members of the Committee:

I appreciate the opportunity to participate in today's hearing to discuss the status of issues associated with the Next Generation Air Transportation System (NextGen)—the planned air traffic management system intended to address current and anticipated aviation congestion. Today, the Nation's air traffic control (ATC) system is experiencing some of the worst delays in recent times, with one in four flights delayed. Currently, the U.S. air transportation system handles roughly 50,000 flights over a 24-hour period. By 2025, air traffic is projected to double or triple, increasing to 100,000 to 150,000 flights every 24 hours. Stakeholders acknowledge that the current air transportation system will not be able to meet these air traffic demands.

Recognizing the need to transform the current system and to prepare for the forecasted growth in air traffic, Congress in 2003 mandated the creation of the Joint Planning and Development Office (JPDO)[1] to conceptualize and plan for NextGen. JPDO works in partnership with the Departments of Transportation, Commerce, Defense (DOD), and Homeland Security (DHS); the Federal Aviation Administration (FAA); the National Aeronautics and Space Administration (NASA); the White House Office of Science and Technology Policy; and the private sector. Housed within FAA—first as an independent office and now, following restructuring, as a component of FAA's Air Traffic Organization (ATO)—JPDO is responsible for coordinating the related efforts of these partners to plan the transformation to NextGen. JPDO initially prepared three basic planning documents for NextGen—the Concept of Operations, Enterprise Architecture, and Integrated Work Plan (IWP)—which, collectively, form the basis of the joint planning environment for NextGen.

My statement today responds to the six questions you raised about NextGen and JPDO and addresses two related challenges that we have identified in the course of our work—infrastructure issues associated with the configuration of ATC facilities and the capacity of airport runways and staffing issues related to FAA's in-house technical expertise. Your six questions are as follows:

1. Have the views of industry and active air traffic controllers been adequately incorporated in NextGen plans, such as those embodied in the Concept of Operations, Enterprise Architecture, and IWP?
2. Is the current version of IWP sufficiently detailed and prioritized for effective use in overseeing and managing the NextGen-related research of multiple agencies?
3. How confident should Congress be that progress in meeting the research, development, and testing activities set out in IWP will provide a sufficient basis for achieving NextGen's goals and timetable for quieter, cleaner, and more efficient air traffic operations?
4. Can the other partner agencies continue to view JPDO as an "honest broker" in light of FAA's recent restructuring action?
5. What needs to be done to move JPDO from proposing research and development (R&D) for NextGen to articulating a clear R&D program with defined and prioritized tasks?
6. What metrics should Congress use to evaluate the progress of the NextGen initiative?

This statement is based on recent related GAO reports and testimonies, including a report to this committee and other congressional requesters we are issuing today.[2]

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[1] *Vision 100—The Century of Aviation Reauthorization Act,* Pub.L. No. 108–176, § 709.

[2] *Next Generation Air Transportation System: Status of Systems Acquisition and the Transition to the Next Generation Air Transportation System,* GAO–08–1078 (Washington, D.C.: Sept. 11, 2008); *Aviation and the Environment: NextGen and Research and Development Are Keys to Reducing Emissions and Their Impact on Health and Climate,* GAO–08–706T (Washington, D.C.:

Our work on this most recent report included interviewing 25 key NextGen stakeholders about the progress of and challenges to planning for and achieving the transition to NextGen. We conducted this work in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the work to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

NextGen is a multi-decade, multi-agency effort to transform the current ATC system to the next generation air transportation system by moving from relying largely on ground-based radars to using precision satellites; digital, networked communications; and an integrated weather system. Often characterized as "curb to curb," NextGen involves every aspect of air transportation, from arrival at the airport to departure from the destination airport, and it is expected to increase the safety and enhance the capacity of the air transport system. JPDO was charged with coordinating the research activities of the federal partner agencies with the goal of developing a 20-year R&D agenda for NextGen. FAA will play the central role in implementing NextGen, since it will be responsible for acquiring, integrating, and operating the new ATC systems. Industry stakeholders will also play a key role in implementing NextGen because they are expected to develop, finance, and operate many of the new NextGen systems that will need to be installed in aircraft. FAA plans to spend roughly $5.4 billion from fiscal years 2009 through 2013 on NextGen development and capital costs. JPDO estimated that total federal spending for NextGen may range from $15 billion to $22 billion through 2025. The agency also noted that it expects system users to incur $14 billion to $20 billion in costs to equip themselves with the advanced avionics necessary to realize the full benefits of some NextGen technologies.

JPDO's authorizing legislation requires the office to create an R&D plan for the transition to NextGen. This requirement led JPDO to develop initial versions of the Concept of Operations, Enterprise Architecture, and IWP. The Concept of Operations is the fundamental planning document from which the other two documents flow. Version 2 of the Concept of Operations, issued in June 2007, describes how the NextGen system is envisioned to operate in 2025. Version 2 of the Enterprise Architecture, issued in July 2007, is a technical description of the NextGen system, akin to blueprints for a building. The Enterprise Architecture provides a means for coordinating among the partner agencies and private sector manufacturers, aligning relevant R&D activities, and integrating equipment. Version 0.2 of IWP describes the integrated framework needed to transition to NextGen from the current system to the end state and will continually be refined and enhanced to reflect current priorities, budgets, and programs. It is JPDO's plan for achieving NextGen. Version 1.0 of IWP is scheduled to be released at the end of this month.

Have the Views of Industry and Air Traffic Controllers Been Adequately Incorporated in NextGen Planning Documents?

JPDO, FAA, and industry stakeholders have different perspectives on whether the views of industry and air traffic controllers have been adequately incorporated in NextGen planning. JPDO's organizational structure and processes provide for industry representatives and, to a lesser extent, air traffic controllers to participate in NextGen planning, but nearly all the industry stakeholders we spoke with questioned both the meaningfulness of their involvement and the usefulness of the NextGen planning documents. Furthermore, active air traffic controllers maintain that they have not participated in NextGen development activities. According to FAA, however, their involvement will increase as NextGen efforts shift from planning to implementation.

JPDO includes several organizations with industry participants, and industry representatives have reviewed and provided input to key JPDO planning documents.

May 6, 2008); *Aviation and the Environment: FAA's and NASA's Research and Development Plans for Noise Reduction Are Aligned but the Prospects of Achieving Noise Reduction Goals Are Uncertain,* GAO–08–384 (Washington, D.C.: Feb. 15, 2008); *Next Generation Air Transportation System: Status of the Transition to the Future Air Traffic Control System,* GAO–07–784T (Washington, D.C.: May 9, 2007); *Joint Planning and Development Office: Progress and Key Issues in Planning the Transition to the Next Generation Air Transportation System,* GAO–07–693T (Washington, D.C.: Mar. 29, 2007); and *Federal Aviation Administration: Key Issues in Ensuring the Efficient Development and Safe Operation of the Next Generation Air Transportation System,* GAO–07–636T (Washington, D.C.: Mar. 22, 2007).

For example, JPDO's NextGen Institute serves as a vehicle for incorporating the expertise of industry, State and local governments, and academia into the NextGen planning process. Additionally, the Institute Management Council, composed of top officials and representatives from the aviation community, including air traffic controllers, oversees the policies, recommendations, and products of the Institute and provides a means for advancing consensus positions on critical NextGen issues. JPDO also includes nine working groups,[3] through which federal and private sector stakeholders come together to plan for and coordinate the development of NextGen technologies. JDPO created the working groups in early 2007 to replace its integrated product teams and, in part, to address concerns expressed by stakeholders about their participation. Unlike the previous teams, which were chaired by a representative from a federal agency, the working groups, which have the same members as the previous teams, are jointly led by government and industry officials. (See Table 1.) JPDO expected the working groups to be more efficient and output- or product-focused than the integrated product teams. Currently, 265 industry representatives participate in JPDO. In addition, JPDO provided a draft of the Concept of Operations and IWP to industry representatives for review and comment. For example, version 0.2 ofIWP was circulated to stakeholders and, according to a senior JPDO official, the office received about 1,100 stakeholder comments, which were addressed and incorporated in version 1.0 of the document.

Table 1: JPDO's Working Groups, Strategies, and Agency and Industry Leads

Working group	Strategy	Agency lead	Industry lead
Airport	Develop airport infrastructure to meet future demand	FAA	Trillion Aviation
Security	Establish an effective security system without limiting mobility or civil liberties	DHS	Global Initiative
Air Navigation Services	Develop air traffic management and air traffic control procedures for safe and efficient flight operations	FAA	Computer Sciences Corporation
Aircraft	Develop plans and recommendations for the performance, function, and capabilities of aircraft that will enable NextGen operations	FAA	Boeing
Net-Centric Operations	Develop a robust, globally interconnected network in which information is shared in a timely and consistent way among aviation users	DOD	Boeing
Safety	Establish a comprehensive and proactive approach to safety	FAA	Boeing
Environment	Develop environmental protection that allows sustained aviation growth	FAA	Aerospace Industries Association
Weather	Develop a systemwide capability to reduce weather impacts	Department of Commerce	National Business Aviation Association
Global Harmonization	Harmonize equipment and operations globally	FAA	Lockheed Martin

Sources: GAO and JPDO.

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

With these efforts, JPDO has sought to obtain participation from industry stakeholders and air traffic controllers in its planning activities, and we have reported that many stakeholders felt they did have an opportunity to participate.[4] In fact, one industry stakeholder group told us that it worked closely with JPDO to help revise an early version of the Concept of Operations. However, other stakeholders said they frequently attended meetings, but were frustrated by a lack of tangible products being developed and a lack of progress being made during these meetings. Furthermore, 13 of 15 stakeholders who discussed the issue stated that they did not feel that their level of participation in either JPDO's planning for or FAA's implementation of NextGen allowed for sufficient or meaningful input toward decision-making. Some stakeholders expressed concern that JPDO and FAA did not include their input in planning documents and other products. In their view, critical issues they raised are not being addressed or incorporated in NextGen plans. In particular, some stakeholders noted that planning documents were drafted by JPDO staff and then provided to them for review and comment. This approach, one industry stakeholder noted, did not take full advantage of stakeholders' capabilities. Others were critical of FAA's decision-making structure for implementing NextGen and indicated they felt that FAA and JPDO should lay out the broad plans and schedules for NextGen and then obtain industry input on the best ways to accomplish the technical changes for NextGen. Another stakeholder indicated it had the opportunity to provide input to FAA on decisions such as the deployment of ADS–B technology, but did not feel its input was considered by the agency. Still others felt that FAA provided sufficient briefings on NextGen activities, but allowed no opportunity for their input or comments.

A number of stakeholders also expressed concerns about the usefulness of JPDO's three planning documents and of FAA's implementation plan for NextGen (a document previously known as the Operational Evolution Partnership and now called the NextGen Implementation Plan). Nineteen of 21 industry stakeholders who discussed the issue said that these planning documents lack the information that industry participants need for successful planning. Many of the stakeholders we interviewed said that while the planning documents provide a high-level view of NextGen benefits, they do not provide specific details such as a catalog of critical needs, clearly defined and prioritized intermediate objectives, and a structured plan for achieving tangible results. According to stakeholders who manufacture aviation equipment, the plans lack specific details to inform them about the types of technology they need to design for NextGen or to provide insights to market, build, and install systems that support NextGen. Some industry stakeholders further noted that the current planning does not identify all of the key research for NextGen, establish priorities for R&D, or show how to obtain those results. In addition, several stakeholders characterized the documents as long and confusing—qualities that detracted from their usefulness. We agree that the latest publicly available versions of these documents lack information that various stakeholders need. For example, the documents do not include key elements such as scenarios illustrating NextGen operations; a summary of NextGen's operational impact on users and other stakeholders; and an analysis of the benefits, alternatives, and trade-offs that were considered for NextGen. Our review of the upcoming version of IWP confirmed that it is to have information that is lacking in the current document. According to JPDO and FAA officials, it includes schedule information that has been updated to reflect newly available information, coordination with FAA's schedule and plans, and revisions in response to public comments received on the previous version. In addition, a senior JPDO official noted and we agree that these documents are not the appropriate place for some of the detailed information stakeholders would like and need, such as specific information on the types of technology stakeholders need to design or install.

Active air traffic controllers are represented on JPDO's Institute Management Council, and other controllers and aviation technicians participate in certain JPDO efforts. However, stakeholders from the National Air Traffic Controllers Association—an FAA employee union—have indicated that although the union participates in FAA meetings and briefings related to NextGen, it does so as a recipient of information rather than an equal party in the development of NextGen. Technicians in another FAA employee union—the Professional Aviation Safety Specialists—have indicated that they do not participate in NextGen planning or development activities. Although air traffic controllers and technicians will be responsible for a major part of the installation, operations, and maintenance of the systems that NextGen will comprise, our work has shown that these stakeholders have not fully participated in the development of NextGen. Insufficient participation on the part of these

[4] GAO–08–1078.

employees could delay the certification and integration of new systems and result in increased costs, as we have seen in previous ATC modernization efforts.

FAA officials, however, note that both unions are represented on its NextGen Management Board, a decision-making body for resolving emerging NextGen implementation issues. Furthermore, FAA has indicated that air traffic controllers, pilots, and airline operations center personnel will be a part of the extended team that is directly involved in the planning and execution of a gradual roll-out of NextGen technologies and procedures in a Florida demonstration. In addition, according to FAA, these stakeholders will continue to be heavily involved in NextGen throughout its life cycle through their participation on advisory committees such as RTCA,[5] the Air Traffic Management Advisory Committee,[6] the Performance-Based Operations Aviation Rule-making Committee,[7] and the Research, Engineering and Development Advisory Committee.[8]

FAA and JPDO have established mechanisms for obtaining stakeholder views. However, given the large number of NextGen stakeholders and the evolution of opportunities for participation in NextGen, we believe that stakeholders will continue to differ on how adequately their views have been incorporated in NextGen planning.

Is the Current Version of IWP Sufficiently Detailed for Effective Use in Overseeing and Managing NextGen?

Our work indicates that the current version of the IWP lacks critical information and is not sufficiently "user friendly" to be effectively used to oversee and manage NextGen activities. For instance, 19 of the 21 stakeholders who discussed the issue said that the planning documents did not provide specific details such as a catalog of critical needs, clearly defined and prioritized intermediate objectives, and a structured plan for achieving tangible results. However, the next version of the plan, to be released at the end of September, is to have further details and research priorities that should be useful for NextGen oversight. According to senior JPDO officials, this next version will identify the specific operational improvements and capabilities that NextGen will incorporate and will show what policies, research, and other activities are needed to enable those improvements and capabilities, when they are needed, and what entities are responsible for them. Moreover, this version includes schedule information that has been updated to reflect newly available information, coordination with FAA schedules and plans, and public comments received on the previous version, according to JPDO and FAA officials. Our review of the upcoming version—which is an automated, searchable, user-friendly database—verified that it will have the capability to track dates and identify programs that are behind schedule, making it useful, but not sufficient, for oversight.

Senior JPDO officials expect subsequent versions of IWP to include cost information and more detail on which programs are responsible for completing particular actions. We believe that JPDO's upcoming version of the work plan shows progress in providing needed details and making the document more useful than earlier versions. With cost information, subsequent versions of the plan should be even more useful for NextGen oversight.

How Confident Should Congress Be that IWP Will Provide a Sufficient Basis for Achieving NextGen's Goals?

The research, development, and testing activities set out in the current IWP do not provide a sufficient basis for Congress to be confident that the goals of NextGen will be achieved. However, the enhanced information that is planned for inclusion in the upcoming version will provide a firmer basis for congressional confidence. The current plan can best be viewed as a necessary but not a sufficient step in the planning and early implementation of NextGen. However, additional issues that are not part of the current plan will have to be addressed to achieve NextGen goals, such

[5] Once called the Radio Technical Commission for Aeronautics, RTCA is a private, not-for-profit corporation that develops consensus-based performance standards for ATC systems.

[6] The Air Traffic Management Advisory Committee, a component of RTCA, provides FAA with consensus-based, recommended investment priorities that are expected to improve the safety, capacity, and efficiency of the air transportation system.

[7] The Performance-Based Operations Aviation Rule-making Committee was established by FAA to provide a forum for the U.S. aviation community to discuss, prioritize, and resolve issues; provide direction for U.S. flight operations criteria; and produce U.S. consensus positions for global harmonization.

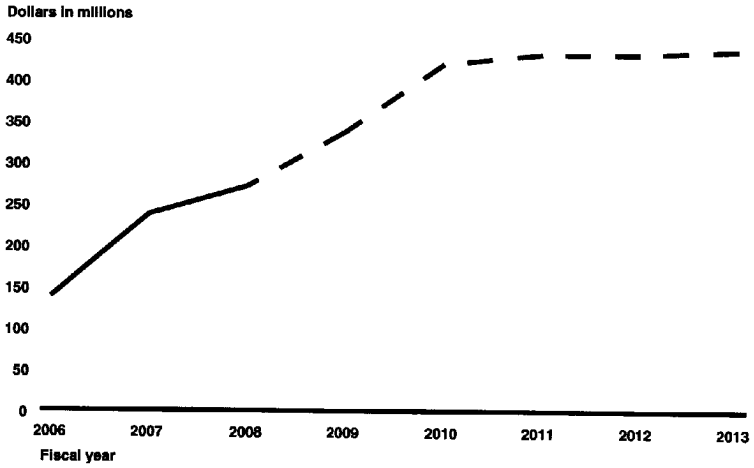
[8] The Research, Engineering and Development Advisory Committee advises the FAA Administrator on R&D issues and coordinates FAA's research, engineering, and development activities with industry and other government agencies.

as obtaining the necessary funding, establishing the infrastructure to support the scope of needed R&D, and filling the gap that may exist between basic research and the research needed to bring technologies far enough along for transfer to industry for further development.

JPDO and FAA have determined that research gaps now exist because of cuts in NASA's aeronautical research funding and NextGen's expanded research requirements. In the past, NASA performed a significant portion of aeronautics R&D. However, NASA's aeronautic research budget declined from about $959 million in fiscal year 2004 to $511 million in fiscal year 2008. While NASA still plans to focus some of its research on NextGen needs, the agency has moved toward a focus on fundamental research and away from developmental work and demonstration projects. As a result, in some cases, NASA's research focuses on developing technologies to a lower—and therefore less readily adopted—maturity level than in the past.

Budget requests for FAA have increased to help provide the needed R&D funding for NextGen. According to FAA, the agency will spend an estimated $740 million on NextGen-related R&D during fiscal years 2009 through 2013. The administration's proposed budget for fiscal year 2009 requests $56.5 million for FAA R&D to support the integration and implementation of NextGen programs, a substantial increase over the $24.3 million authorized for fiscal year 2008. The actual and projected increase in FAA's overall R&D funding reflects the expected increases in NextGen research funding. (See Fig. 1.) In addition, increased funding for NextGen R&D is contained in proposed legislation to reauthorize FAA, although that legislation has not been enacted.

Figure 1: FAA's R&D Budget for Fiscal Years 2006 through 2008 and Proposed Budget through Fiscal Year 2013, in Constant 2008 Dollars



Source: GAO analysis.

If FAA is authorized to receive increased R&D funding for NextGen, some observers believe that the agency lacks the R&D infrastructure to adequately address the developmental research needed for NextGen. According to a draft report by the Research, Engineering and Development Advisory Committee, establishing the infrastructure within FAA to conduct the necessary R&D could delay the implementation of NextGen by five years. Unless an adequate R&D infrastructure is in place as funds become available, the implementation of NextGen could be delayed.

One critical area in which an R&D gap has been identified is the environmental impact of aviation. According to a JPDO analysis, environmental impacts will be the primary constraint on the capacity and flexibility of the national airspace system unless these impacts are managed and mitigated. FAA's Continuous Lower Energy, Emissions, and Noise (CLEEN) initiative, in which NASA would participate as an adviser, is intended to address the gap between NASA's fundamental research in noise reduction and the need for near-term demonstrations of technology. This program would establish a research consortium of government, industry, and academic

participants that would allow for the maturation of these technologies via demonstration projects.[9] In proposed legislation reauthorizing FAA, $111 million for fiscal years 2008 through 2011 may be used for a new FAA program to reduce aviation noise and emissions.[10] This program would, over the next 10 years, facilitate the development, maturation, and certification of improved airframe technologies.

The CLEEN program would be a step toward further maturing emissions and noise reduction technologies, but experts agree that the proposed funding is insufficient to achieve needed emissions reductions. While acknowledging that CLEEN would help bridge the gap between NASA's R&D and manufacturers' eventual incorporation of technologies into aircraft designs, aeronautics industry representatives and experts we consulted said that the program's funding levels may not be sufficient to attain the goals specified in the proposal. According to these experts, the proposed funding levels would allow for the further development of one or possibly two projects. Moreover, in one expert's view, the funding for these projects may be sufficient to develop the technology only to the level that achieves an emissions-reduction goal in testing, not to the level required for the technology to be incorporated into a new engine design. Although we believe that this level of funding is a step in the right direction, additional funds would permit the agency to "buy down" R&D risks—that is, the more projects that can be funded, the greater the chance that at least one of the projects will yield a product for the next stage of development. FAA recognizes the implications of the proposed funding structure for CLEEN and characterizes the program as a "pilot."

We are guardedly optimistic that the NextGen goals and timetable for quieter, cleaner, and more efficient air traffic operations can be achieved.

The administration has requested increased funding for NextGen R&D and FAA and JPDO recognize the need to establish an R&D infrastructure and fill any gaps that may exist between basic research and the transfer to industry for further development.

Can JPDO Continue to Be Viewed as an "Honest Broker" in Light of FAA's Recent Restructuring?

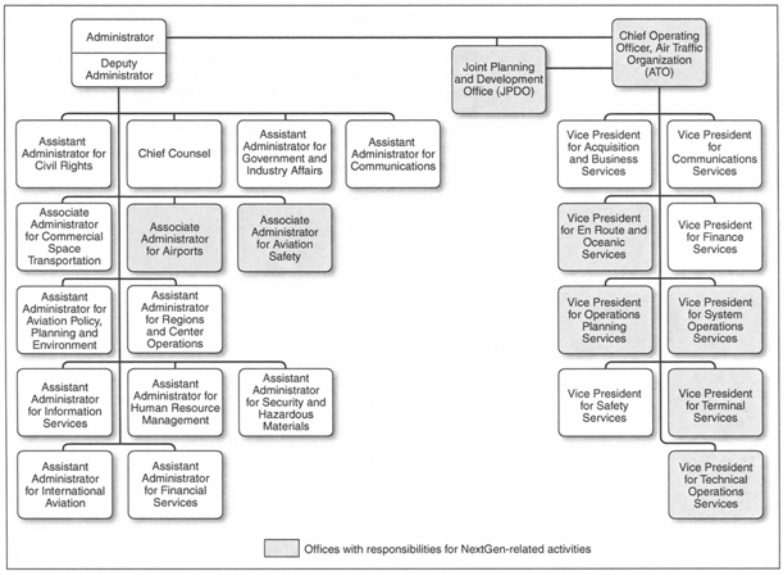
Prior to May 2008, when FAA restructured ATO, JPDO reported directly to both the Chief Operating Officer (COO) of ATO and the FAA Administrator. Figure 2 shows FAA's management structure as of November 2007, with the shaded boxes showing offices with responsibilities for NextGen activities. We expressed concerns about this dual reporting status, suggesting that it might keep JPDO from interacting on an equal footing with ATO and the other partner federal agencies.[11] We recognized that JPDO needed to counter the perception that it was a proxy for ATO and, as such, was not able to act as an "honest broker" between ATO and the partner federal agencies, but we also understood that JPDO must continue to work with ATO and its partner agencies in a partnership in which ATO is the lead implementer of NextGen. Therefore, we reported that it was important for JPDO to have some independence from ATO and pointed out that, to address this issue, the JPDO Director could report directly to the FAA Administrator. We observed that such a change could also lessen what some stakeholders perceived as unnecessary bureaucracy and red tape associated with decision-making and other JPDO and NextGen processes.

[9] GAO–08–384.

[10] H.R. 2881, § 505.

[11] GAO, *Responses to Questions for the Record; Hearing on the Future of Air Traffic Control Modernization,* GAO–07–928R (Washington, D.C.: May 30, 2007).

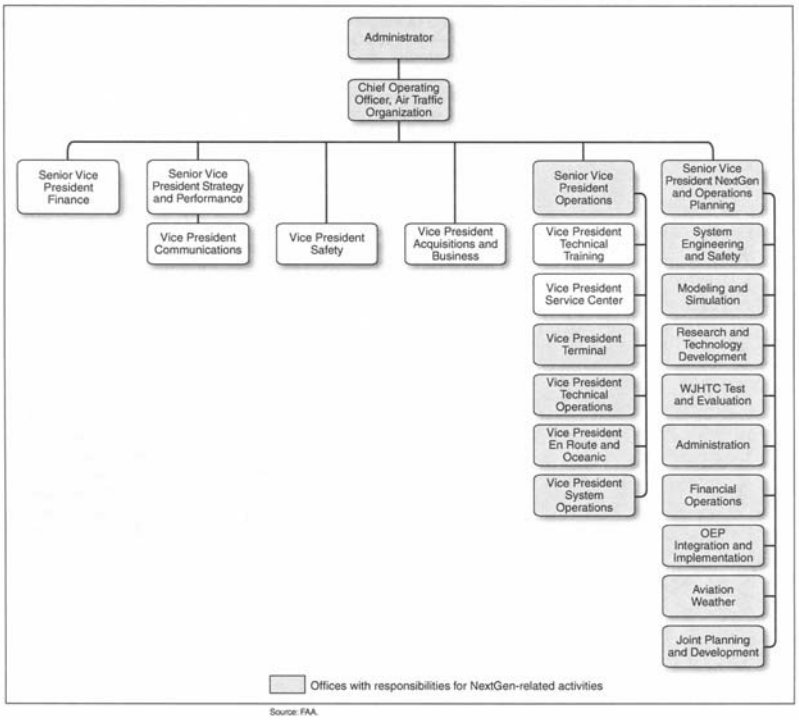
Figure 2: FAA Organization, November 2007



Source: FAA.

Since ATO was reorganized in May 2008, JPDO has been housed within the new NextGen and Operations Planning Office and reports through the Senior Vice President for NextGen and Operations Planning only to ATO's COO. (See Fig. 3.) Now that JPDO is no longer a separate, independent office within FAA and no longer reports directly to the FAA Administrator, its organizational position within FAA has declined. Nonetheless, we believe that it is too early to tell whether JPDO will be able to act as an "honest broker" between FAA and the other federal partner agencies. Currently, according to a senior JPDO official, JPDO's partner agencies are cooperating with JPDO, indicating that the office is apparently maintaining its status as an honest broker.

Figure 3: ATO Organization, July 2008



Source: FAA.

However, it is also too early to tell if ATO's reorganization sufficiently addresses concerns that many industry stakeholders expressed about the adequacy of the previous organizational relationship between FAA and JPDO—when JPDO reported directly to both the COO and the Administrator—for the transition to NextGen. Proposed legislation reauthorizing FAA would address the earlier concern of stakeholders by designating the Director of JPDO as the Associate Administrator for the Next Generation Air Transportation System, appointed by and reporting directly to the Administrator.[12] The proposed legislation would also address observations we have made about JPDO's organizational placement within FAA.

Finally, it is too early to tell if the reorganization of FAA's management structure addresses concerns that stakeholders have expressed about the fragmentation of management responsibility for NextGen activities. Specifically, some industry stakeholders expressed frustration that a program as large and important as NextGen does not follow the industry practice of having one person authorized to make key decisions. They pointed out that although FAA's COO is nominally in charge of FAA's NextGen efforts, the COO must also manage the agency's day-to-day air traffic operations and may therefore be unable to devote enough time and attention to managing NextGen. In addition, these stakeholders noted that many of NextGen's capabilities span FAA operational units both within and outside ATO. The reorganization does not address concerns about this fragmentation, since other offices in ATO and FAA continue to have responsibility for parts of NextGen and the division of responsibility for NextGen efforts among them is not clear. A senior FAA official noted that ATO executives are knowledgeable and supportive of the reorganization, but that the agency could better communicate the changes to stakeholders outside of FAA. A focused outreach to industry stakeholders would help to get their buy-in and support of FAA's efforts.

[12] H.R. 2881, § 202.

What Needs to Be Done to Move JPDO from Proposing R&D to Articulating a Clear R&D Program with Defined and Prioritized Tasks?

To articulate a clear R&D program with defined and prioritized tasks, JPDO must continue to collaborate with its partner agencies—FAA, NASA, DOD, DHS, and Commerce—to identify and prioritize the R&D needed for NextGen. As it issues new versions of IWP, JPDO continues to update the R&D plans of the partner agencies. However, JPDO has not yet determined what NextGen R&D needs to be done first and at what cost to demonstrate and integrate NextGen technologies into the national airspace system. The next version of IWP, scheduled to be released later this month, is to identify the sequence of research activities that the partner agencies must complete before specific NextGen capabilities can be implemented. The plan should serve as a useful tool in prioritizing and tracking NextGen research. In addition, JPDO has worked with the Office of Management and Budget (OMB) to develop a process that allows OMB to identify NextGen-related research and acquisition projects across the partner agencies and consider NextGen as a unified, cross-agency program. Under this process, JPDO and its partner agencies can jointly present OMB with business cases for the partner agencies' NextGen-related efforts, and these business cases can be used as inputs to funding decisions for NextGen research and acquisitions across the agencies.

In addition, JPDO needs to continue to leverage the R&D programs of the partner agencies, which will conduct and define the research. For example, JPDO monitors NASA's and FAA's efforts to coordinate their research. NASA and FAA have developed a strategy to identify, conduct, and transfer to FAA the R&D needed for NextGen. The strategy establishes four "research transition teams"[13] that align with JPDO's planning framework and outlines how the two agencies will jointly develop research requirements—FAA will provide user requirements and NASA will conduct the research and provide an understanding of the engineering rationale for design decisions. In addition, the strategy calls for clearly defining metrics for evaluating the research. According to JPDO, as of August 2008, four teams had been established and have conducted initial meetings.

JPDO has begun to move from proposing research to articulating a defined and prioritized R&D program. In addition, JPDO, FAA, and NASA have established mechanisms, such as research transition teams, to define and prioritize R&D. We believe, however, that it is still too early to assess the adequacy of these efforts.

What Metrics Should Congress Use to Evaluate the Progress of NextGen?

Version 1.0 of IWP, scheduled to be released later this month, will provide a baseline for measuring NextGen progress. Congress can use the information contained in the plan to help evaluate whether the actions needed to achieve NextGen are on schedule and whether the specific operational improvements and capabilities that will make up NextGen are being accomplished. Specifically, subsequent versions of the plan will allow the development of metrics to show progress, by agency, in (1) achieving key activities and deploying technology, (2) issuing policies and guidance, and (3) prioritizing resources.

Furthermore, subsequent versions of IWP are expected to include cost information that decision-makers can use to help understand the rationale for budget requests, monitor costs, and improve future cost estimates for acquisitions. This information will be helpful to decision-makers when budget constraints do not allow all system acquisitions to be fully funded at planned and approved levels and they must decide which programs to fund and which to cut or delay according to their priorities.

Two Related Challenges

At this point, Mr. Chairman, I would like to briefly discuss two additional issues that present challenges to realizing the full potential of NextGen. The first, an infrastructure challenge, is to implement NextGen plans for a new configuration of ATC facilities and enhanced runway capacity. The second, a human capital challenge, is to ensure that FAA staff have the knowledge and skills needed to implement NextGen.

To fully realize NextGen's capabilities, a new configuration of ATC facilities and enhanced runway capacity will be required to go along with new technologies and procedures. According to a senior ATO official, the agency plans to report on the cost implications of reconfiguring its facilities in 2009. However, FAA has no comprehensive plan for reconfiguring its facilities. Until the cost analysis is completed and a

[13] The four teams are organized along the framework for near-, mid-, and long-term research goals established in JPDO's IWP. The teams are Separation Management, Trajectory Management, Flow Contingency Management, and Capacity Management.

plan for facilities reconfiguration has been developed, the configurations needed for NextGen cannot be implemented and potential savings that could help offset the cost of NextGen will not be realized. Some FAA officials have said that planned facility maintenance and construction based on the current ATC system are significant cost drivers that could, without reconfiguration, significantly increase the cost of NextGen. Additionally, some of the capacity and efficiency enhancements expected from the implementation of NextGen maybe curtailed if the system's infrastructure needs are not fully addressed.

In the meantime, FAA faces an immediate task to maintain and repair existing facilities so that the current ATC system continues to operate safely and reliably. The agency is currently responsible for maintaining over 400 terminal facilities. While FAA has not assessed the physical condition of all of these facilities, the agency rated the average condition of 89 of them as "fair." Based on its assessment of these 89 facilities, FAA estimated that a one-time cost to repair all 400 terminal facilities would range from $250 million to $350 million. Two FAA employee unions (NATCA and PASS) contend that many of the 400 facilities are deteriorating for lack of maintenance and that working conditions are unsafe because of leaking roofs, deteriorating walls and ceilings, and obsolete air-conditioning systems. According to FAA officials, while some of these facilities can accommodate NextGen's new technologies and systems, many of them are not consistent with the configurations that will be needed under NextGen. Once FAA develops and implements a facility consolidation plan, the costs of facility repairs and maintenance may be reduced. In the meantime, FAA will have to manage its budgetary resources so that it can maintain legacy systems and legacy infrastructure while configuring the national airspace system to accommodate NextGen technologies and operations.

The transformation to NextGen will also depend on the ability of airports to handle greater capacity. While NextGen technologies and procedures will enhance this ability, new or expanded runways will likely be needed also to handle the expected increases in traffic. FAA has developed a rolling 10-year plan for capacity improvements at the Nation's 35 busiest airports, and some airports are building new runways. However, even with these planned runway improvements, FAA analyses indicate that 14 more airports will still need additional capacity. Moreover, without significant reductions in emissions and noise around some of the Nation's airports, efforts to expand their capacity could be stalled or the implementation of NextGen delayed. We believe that this is a significant issue that FAA and JPDO will have to address.

To manage the implementation of NextGen, FAA will need staff with technical skills, such as systems engineering and contract management expertise. Because of the scope and complexity of the NextGen effort, the agency may not currently have the in-house expertise to manage the transition to NextGen without assistance. In November 2006, we recommended that FAA assess the technical and contract management skills FAA staff will need to define, implement, and integrate the numerous complex programs that will be involved in the transition to NextGen.[14] In response to our recommendation, FAA contracted with the National Academy of Public Administration (NAPA) to determine the mix of skills and number of skilled persons, such as technical personnel and program managers, needed to implement NextGen and to compare those requirements with FAA's current staff resources. NAPA expects to complete its assessment in September 2008. We believe this is a reasonable approach that should help FAA begin to address this issue, recognizing that once the right skills have been identified, it may take considerable time to select, hire, and integrate what FAA estimates could be 150 to 200 more staff. This situation could contribute to delaying the integration of new technologies and the transformation of the national airspace system.

Mr. Chairman, this concludes my prepared statement. I would be pleased to respond to any questions that you or other Members of the Committee may have.

BIOGRAPHY FOR GERALD L. DILLINGHAM

Dr. Dillingham is currently serving as the Director of Civil Aviation Issues for the U.S. Government Accountability Office (GAO) in Washington, D.C. GAO is the investigative and research arm of the U.S. Congress. He is responsible for directing program evaluations and policy analyses related to all aspects of civilian aviation, including safety, finance, environment, air traffic control, airport development, and international aviation issues.

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

Dr. Dillingham received his Master's and doctorate from the University of Chicago and was a postdoctoral scholar in program evaluation at the University of California–Los Angeles. He is a recognized expert in program evaluation, policy analyses, and aviation issues. He has managed research teams, conducted national and international evaluation studies, and published studies in a wide variety of subject areas. He served on the National Commission on Terrorist Attacks Upon the United States (9/11 Commission)—Aviation and Transportation Security Team. He has testified as an expert witness before numerous committees of the U.S. Congress.

Chairman GORDON. Thank you for that view. Mr. Scovel.

STATEMENT OF THE HONORABLE CALVIN L. SCOVEL III, INSPECTOR GENERAL, U.S. DEPARTMENT OF TRANSPORTATION

Mr. SCOVEL. Chairman Gordon, Ranking Member Hall, Members of the Committee, we appreciate the opportunity to discuss the status of FAA's efforts to develop NextGen. This is a high-risk effort involving billion dollar investments from the government and air space users who will be expected to equip with new avionics. Today we will address four points.

First, FAA is at a crossroads with modernizing the National Airspace System. The agency faces challenges to keep existing systems on track, maintain aging facilities, and develop and implement NextGen initiatives. As we reported in April, 30 existing projects form platforms for NextGen, and over 20 critical decisions need to be made over the next two years that have enormous budgetary implications.

To help bridge the transition from today's system to a vastly different NextGen, we recommended that FAA conduct a gap analysis of the current NextGen Systems and develop an interim architecture for the 2015 timeframe. FAA is taking steps to address our recommendations.

Second, significant issues related to resource alignment, research priority, and policy questions that will materially affect the cost and schedule for NextGen need to be addressed. A key issue focuses on NASA's work to develop advanced NextGen software for boosting controller productivity.

NASA R&D is fairly well aligned with JPDO plans but falls short with respect to validating new software and linking airport arrival and departures. We found that FAA, DOD, and DHS need to reach an agreement on NextGen security and surveillance issues. Work is also needed to reconcile differences on new weather systems including the new 4–D Weather Cube, a simple database for weather observations.

In addition, attention is needed to make sure human factors research for controllers and pilots is effectively linked to ensure that NextGen capabilities can be safely implemented.

Third, how FAA is organized to manage and execute NextGen is an important matter. FAA's decision to place the JPDO within the ATO could help in implementing NextGen. It has the benefit of placing developmental efforts much closer to the people who will use new systems.

However, it gives the appearance that JPDO has been reduced in status and importance. We think it's premature to judge the change, but we found that FAA needs to clarify roles and respon-

sibilities among offices, the JPDO and the new ATO NextGen Office for implementation and integration.

Further, budget authority for NextGen efforts remains fragmented among FAA lines of business. How to best organize FAA is a policy call for Congress. We think FAA will have to revisit the governance of NextGen once it has a clearer picture of what it will take to deliver NextGen.

Finally, a number of actions are needed from FAA going forward to help NextGen efforts from research to implementation. NextGen will be a front and center issue for the next Congress and a top management challenge for the new Administration. We have made numerous recommendations to FAA aimed at reducing risks with NextGen. They focused on funding targeted human factors research and acquiring the skill sets needed to execute NextGen.

At this juncture a number of additional actions are needed, and I will highlight five. Action item number one. Establish priorities and reflect them in budgets and plans. Decision-makers do not have a clear understanding of what to invest in first. FAA should provide this committee with its priorities for NextGen R&D, how research gaps will be addressed, and how priorities will be updated as they evolve.

Action item two. Develop a strategy for technology transfer. This is critical to the JPDO's mission. FAA has established research transition teams for NASA work but not for other areas. Our work shows that this needs more attention. Clearly-defined exit criteria and hand-off points would help transition new technologies into day-to-day use.

Action item three. Focus attention on airport issues and how NextGen technologies can unlock already congested airports. This should be a top priority, and an important metric for NextGen must be the extent to which FAA can improve airport arrival rates under all weather conditions. FAA recognizes the importance and is shifting resources to this issue, however, much work remains, and stakeholders need to know how NextGen elements, new satellite-based systems, new automation, data link communications can boost airport capacity.

Action item four. Develop a realistic plan for ADS–B, a centerpiece of NextGen. FAA has a $1.8 billion contract in place for this ground system and has published a proposed rule for the new satellite-based surveillance system. FAA plans call for users to equip with ADS–B OUT in the 2020 timeframe, but it is unclear when ADS–B IN and the related capacity related benefits can be realized. Concerns have been raised about requirements, the cost to equip, and the lack of clear benefits, all legitimate issues that need to be addressed.

Action item five. Assess implementation band width and develop transition benchmarks. FAA's ability to implement multiple capabilities in a given time period needs to be assessed. FAA and industry need realistic transition benchmarks that point to when new training for controllers and pilots, equipment, and procedures need to be in place at specific locations.

Mr. Chairman, that concludes my statement. I would be happy to answer your questions, you or other Members of the Committee may have.

[The prepared statement of Mr. Scovel follows:]

PREPARED STATEMENT OF CALVIN L. SCOVEL III

Mr. Chairman and Members of the Committee:

We appreciate the opportunity to discuss the status of the Federal Aviation Administration's (FAA) efforts to develop the Next Generation Air Transportation System (NextGen), which is targeted for the 2025 timeframe. In response to congressional direction, FAA created the Joint Planning and Development Office (JPDO) to develop a vision for NextGen and leverage research at other federal agencies.

As the Committee is aware, there are a number of compelling reasons for moving forward with NextGen. The current air transportation system has served the Nation well over the years, but "business as usual" will not be sufficient to meet the anticipated demand for air travel or significantly reduce delays at already congested airports.

Currently, the U.S. airline industry is facing considerable financial uncertainty due to a softening economy and skyrocketing fuel prices. In response, airlines are reducing schedules and taking aircraft out of service. Notwithstanding the state of the industry, it is important to move forward with NextGen. FAA is revising its forecast but still projects that the demand for air travel will grow to more than one billion passengers by 2016.

NextGen goals are ambitious but important to the health of the U.S. air transportation system and the Nation's economy. NextGen is expected to triple capacity, boost controller productivity, reduce FAA operating costs, lessen impact of high energy costs, and reduce the environmental impact of aviation.

Developing NextGen is one the biggest challenges facing FAA. It is a high-risk effort involving billion-dollar investments from both the Government (for new ground systems) and airspace users (for new avionics). FAA plans to spend $18 billion for its capital programs between fiscal years (FY) 2008 and 2013, including $5.6 billion specifically for NextGen. The challenges are multi-dimensional and involve complex software development and integration, adjustments to existing air traffic systems, technology transfer, workforce changes, and policy questions about aircraft equipage.

This past year, some stakeholders expressed concern that NextGen efforts lacked a sense of urgency and a clear plan for what could be done in the near-, mid-, and long-term. The Secretary of Transportation is working to clarify NextGen benefits, accelerate efforts, and focus resources.

To its credit, FAA is working on what can be done in the near-term. As part of these efforts, FAA is planning to use new routes that rely on existing avionics onboard aircraft and various demonstration projects. FAA has also made some organizational changes, which included establishing a new Senior Vice President for NextGen Implementation and Operations Planning.

Costs for NextGen remain uncertain, however, and much work remains to set research agendas and priorities for a multi-agency approach, establish requirements for software-intensive acquisitions, determine steps to deliver NextGen capabilities, and develop realistic transition plans. The development and execution of NextGen will require sustained oversight and will therefore be a key issue for the next Congress and a top management challenge for the next administration.

My remarks today will focus on four points:

- First, FAA is at a crossroads with modernizing the National Airspace System (NAS) and faces considerable challenges in keeping existing systems on track, maintaining aging facilities, and developing and implementing NextGen initiatives. As we reported in April,[1] approximately 30 existing projects form "platforms" for NextGen, and FAA must make more than 20 critical decisions over the next two years that will have significant budgetary implications. For example, FAA will have to address what changes are needed to modernize its terminal facilities and whether it will pursue a "common automation platform" for terminal and en route environments in the future.

  FAA faces complex integration issues (e.g., linking legacy and new systems) as it must manage interdependencies among diverse programs. To reduce risk and help bridge the transition from today's system to a vastly different NextGen environment, we recommended that FAA conduct a "gap analysis"

[1] OIG Report Number AV–2008–049, "Air Traffic Control Modernization: FAA Faces Challenges in Managing Ongoing Projects, Sustaining Existing Facilities, and Introducing New Capabilities," April 14, 2008. OIG reports and testimonies are available on our website: *www.oig.dot.gov*

of the current and NextGen systems and develop an interim architecture (i.e., technical blueprint) for the 2015 timeframe. FAA is taking steps to address our recommendations.

- Second, progress has been made in coordinating budgets and plans among JPDO partner agencies. However, FAA and its partner agencies need to address significant issues related to resource alignment, research priorities, and policy questions that will materially affect the cost and schedule for NextGen. These issues focus on developing advanced NextGen software for boosting controller productivity; reaching agreement between FAA, the Department of Defense (DOD), and the Department of Homeland Security (DHS) on NextGen security and surveillance issues; reconciling differences on new weather systems; and effectively linking human factors research for controllers and pilots to ensure that NextGen capabilities can be safely implemented.
- Third, how FAA is organized to manage and execute NextGen is an important matter given the high-risk nature of the effort and FAA's past problems with developing new technologies. While FAA's decision to place the JPDO within the Air Traffic Organization (ATO) could help in implementing NextGen capabilities, it also appears to reduce the JPDO in stature and importance. It is premature to judge the effectiveness of this change, but we found that FAA needs to clarify roles and responsibilities among offices (the JPDO and the new NextGen Office for Implementation and Integration). We also note that budget authority for NextGen efforts remains fragmented among FAA lines of business.

  How best to organize FAA is a policy call, but we believe that clear lines of accountability and authority will be critical for managing NextGen. FAA will have to revisit the overall governance of NextGen once it has a better picture of what it will ultimately take to deliver NextGen capabilities.
- Finally, a number of actions are needed from FAA going forward to help shift NextGen efforts from research to implementation. To focus budgetary resources and set expectations for NextGen, FAA must (1) establish priorities and include them in budget and planning documents, (2) focus much needed attention on technology transfer issues, (3) clearly define the roles of the ATO and JPDO and effectively use in-house resources, (4) place a high priority on relieving already congested airports, and (5) examine what can reasonably be implemented in given time increments.

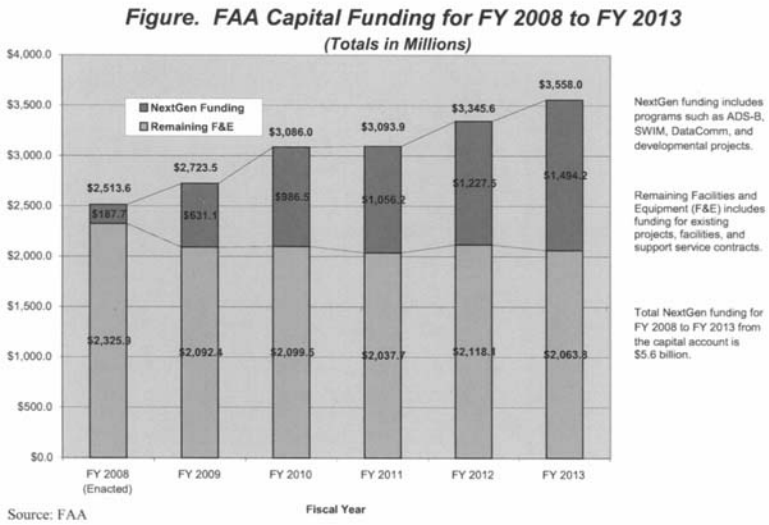
I would now like to discuss these four areas in further detail.

CHALLENGES FACING FAA IN MODERNIZING THE NATIONAL AIRSPACE SYSTEM

FAA is at a crossroads with its efforts to modernize the National Airspace System. The Agency will be challenged to keep ongoing projects on track, maintain aging facilities, and develop and implement NextGen initiatives. For FY 2009, FAA is requesting $2.7 billion for capital funding—an increase of eight percent over last year's enacted level.

FAA is starting a new chapter in modernization with NextGen, and the Agency's capital account is now being shaped by these initiatives. Between FY 2008 and FY 2013, FAA plans to spend $18 billion for capital efforts, including $5.6 billion specifically for NextGen. We note that much of the projected funding for NextGen will focus on developmental efforts, which are funded through the Engineering, Development, Test, and Evaluation portion of the capital account. These efforts are projected to amount to $3.4 billion through FY 2013—a significant portion of the amount dedicated to NextGen spending.

In FY 2009, more than $630 million will be dedicated to NextGen-related programs, which include Automatic Dependent Surveillance–Broadcast (ADS–B) and System-Wide Information Management (SWIM). Of this amount, $203 million is dedicated to eight new developmental initiatives, including NextGen system development, trajectory-based operations, and flexible terminals and airports. The figure below illustrates FAA's planned investments in ongoing projects and NextGen initiatives from FY 2008 to FY 2013.



In addition to capital spending, FAA also plans to spend $374 million in research, engineering, and development funds through FY 2013 for NextGen. These include air-ground integration, wake turbulence, and environmental research.

Progress and Problems With FAA Acquisitions

In our April 2008 report, we examined progress and problems with 18 major acquisitions valued at $17.5 billion. Overall, we are not seeing the significant cost growth and schedule slips with FAA major acquisitions that occurred in the past. This is because FAA has taken a more incremental approach to managing major acquisitions. When comparing revised baselines, only two of the eighteen projects we reviewed have experienced additional cost growth ($53 million) and delays (five years) since our last report in 2005.[2] However, from program inception, six programs have experienced cost growth of nearly $4.7 billion and schedule delays of one to twelve years.

While FAA's incremental approach may reduce risk in the near-term, it has left several programs with no clear end-state and less visibility into how much they will ultimately cost. A case in point involves modernizing facilities that manage traffic in the vicinity of airports, which is commonly referred to as "terminal modernization."

In 2004, faced with cost growth of over $2 billion for the Standard Terminal Automation Replacement (STARS) program, FAA rethought its terminal modernization approach and shifted to a phased process, committing STARS to just 50 sites at an estimated cost of $1.46 billion. FAA's original plan was to deploy the system to 172 sites for $940 million. FAA renamed this modernization effort the Terminal Automation Modernization-Replacement (TAMR) initiative.

In 2005, FAA approved modernizing displays through the TAMR program (referred to as TAMR Phase 2) by replacing legacy equipment at five additional small sites and replacing the aging displays at four large, complex facilities. However, this leaves over 100 sites still in need of modernization. FAA has not decided how it will modernize these sites, and costs remain uncertain. For FY 2009, FAA is requesting $31.2 million for terminal modernization efforts.

There is no defined end-state for terminal modernization, and past problems with developing and deploying STARS leave FAA in a difficult position to begin introducing NextGen capabilities. Future terminal modernization costs will be shaped by (1) NextGen requirements, (2) the extent of FAA's terminal facilities consolidation, and (3) the need to replace or sustain existing (legacy) systems that have not been modernized.

[2] 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.

Challenges With Key NextGen Programs

FAA has established initial cost and schedule baselines for the first segments of two key NextGen initiatives: ADS–B and SWIM. Both programs face considerable risks and require significant oversight as FAA begins integrating them with existing systems.

ADS–B: This program provides satellite-based technology that allows aircraft to broadcast their position to other aircraft and ground systems. For FY 2009, FAA is requesting $300 million for ADS–B. In August 2007, FAA awarded a service-based contract for the ADS–B ground infrastructure worth $1.8 billion (if all options are exercised). FAA estimates that ADS–B will cost about $1.6 billion in capital costs for initial implementation segments through 2014. These include completing a nationwide ground system for receiving and broadcasting ADS–B signals.

A key challenge facing FAA—and NextGen implementation—is realizing the full benefits of ADS–B. FAA plans to implement "ADS–B—Out" in the 2020 timeframe, which will require aircraft to broadcast their position to ground systems. However, most capacity and safety benefits from the new system will come from "ADS–B—In," which will display information in the cockpit for pilots. The requirements for ADS–B—In are still evolving and have not been finalized.

FAA must address several risks to realize the benefits of ADS–B. These include: (1) gaining stakeholder acceptance and aircraft equipage, (2) addressing broadcast frequency congestion concerns, (3) integrating with existing systems, (4) implementing procedures for separating aircraft, and (5) assessing potential security vulnerabilities in managing air traffic.

ADS–B implementation is a long-term effort that will require significant investment from the government and industry. Given FAA's history with developing new technologies and its approach to ADS–B, in which the government will not own the ground infrastructure, we believe this program will require a significant level of oversight. We will report on ADS–B later this year.

SWIM: This program provides FAA with a web-based architecture that allows information sharing among airspace users. For FY 2009, FAA is requesting $41 million for SWIM. In June 2007, FAA baselined the first two years of segment 1 (planned to occur between FY 2009 and 2010) for $104 million. FAA's latest Capital Investment Plan cost estimate for SWIM is $285 million.

Current challenges include the work to determine requirements and interfaces with other FAA systems, including the En Route Automation Modernization (ERAM) and Air Traffic Management programs. Moreover, FAA must integrate SWIM with other federal agencies' operations to realize NextGen benefits and develop a robust cyber security strategy and design. While FAA has begun initial efforts, it still needs to establish the architecture, strategy, and design. Additional SWIM segments have yet to be determined, and the cost to fully implement SWIM is unknown. Last month, we began a review of SWIM, which will focus on the strengths and weaknesses of FAA's approach for developing the new system and assess risks that could affect nationwide deployment.

Much Work Remains To Determine How To Transition Existing Projects to NextGen

In February 2007, we recommended that FAA examine existing projects to determine if they were still needed and, if so, what adjustments would be required. FAA concurred with our recommendation and stated that it has begun this assessment. To date, however, FAA has not made major adjustments to modernization projects to accelerate NextGen.

According to FAA, approximately 30 existing capital programs will serve as "platforms" for NextGen. For example, the $2.1 billion ERAM program, which provides new hardware and software for facilities that manage high-altitude traffic, is a lynchpin for the NextGen system. Because ERAM is expected to serve as a foundation for NextGen, any program cost increases or schedule delays will affect the pace of introducing new capabilities. Currently, ERAM software requirements related to NextGen are still uncertain, but costs are expected to be in the billions of dollars.

Over the next two years, FAA must make more than 25 critical decisions about ongoing programs. These decisions have significant budget implications and will affect all major lines of the modernization effort with respect to automation, communications, navigation, and surveillance. For example, FAA will have to address what changes are needed to modernize its terminal facilities and whether it will pursue a "common automation platform" for terminal and en route environments in the future.

Sound investment decisions for NextGen can only be accomplished through a comprehensive enterprise architecture (i.e., technical blueprint) that outlines how the

system will work and what changes to existing programs will be required. The enterprise architecture must establish a transition plan for existing NAS systems that identifies how each system currently functions and it will transition to NextGen. A central element will be outlining a path to develop both existing and proposed automation systems.

FAA has made progress in developing the NextGen Enterprise Architecture, which is planned to be implemented by 2025.[3] FAA has also progressed towards technical roadmaps for the automation, communications, navigation, and surveillance lines of effort. However, planning documents we reviewed, including the NextGen Enterprise Architecture, lack detail with respect to requirements, particularly for automation, that could be used to develop reliable cost estimates and schedule. As we noted in our April report, in most cases, information in the NextGen Enterprise Architecture remained at too high a level to be effective.

To help bridge the transition from the current NAS to NextGen, we recommended several actions to FAA in April, including the following:

- **Conduct a gap analysis of the current NAS and NextGen.** FAA's NextGen architecture does not yet fully detail how FAA will transition from the present NAS and the future NextGen architectures, which are considerably different. Understanding this gap is important because one industry analysis we have seen suggests that FAA could face a $50 billion software development effort with NextGen. Until FAA completes a gap analysis, it will not be possible to determine technical requirements that translate into reliable cost and schedule estimates for major acquisitions. The ATO has begun an analysis of existing modernization efforts and expects to complete it by February 2009.
- **Develop an interim architecture for what can be accomplished by 2015.** Because of the significant differences between the current system and the NextGen architecture and concept of operations, FAA should develop an interim architecture or "way-point" for the 2015 timeframe that is consistent with current NextGen plans. This would help to bridge the gap between current systems and plans for the future. It would also help FAA to determine reasonable goals, establish priorities, fully identify adjustments to existing projects, refine requirements for new systems, and understand complex transition issues. FAA has a mid-term requirements team that is due to report on its activities next summer.

FAA Needs To Address Significant Issues in Coordinating and Aligning JPDO Partner Agencies' Budgets and Plans

The JPDO was mandated by law to coordinate research among diverse federal agencies to develop NextGen in the 2025 timeframe. This is an important mission given that FAA conducts very little long-term air traffic management research. Central to making the JPDO an effective multi-agency vehicle is alignment of resources. This is a complex task, and the JPDO has no authority to adjust or redirect the research budgets of other federal agencies.

We have seen some progress with the various "mechanisms of alignment," including the NextGen Concept of Operations, the NextGen Enterprise Architecture, and the Integrated Work Plan[4] since our February 2007 report.[5] In addition, the JPDO now has a signed Memorandum of Agreement with all partner agencies and has published a NextGen research and development plan. An exhibit to our statement details the various mechanisms of alignment we reviewed.

However, the NextGen Enterprise Architecture and Integrated Work Plan continue to evolve and remain at a very high level. These documents are not yet mature enough to drive investment decisions or generate requirements for major NextGen acquisitions, particularly for new software-intensive systems. As noted by the National Research Council,[6] these efforts still reflect a lack of top-level system engineering and clearly established priorities. JPDO officials told us that it will take

[3] The NextGen 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.

[4] The JPDO's Integrated Work Plan is akin to a project plan and is meant to describe the capabilities needed to transition to NextGen from the current system and provide the research, policy, regulation, and acquisition timelines necessary to achieve NextGen by 2025.

[5] OIG Report Number AV–2007–031, "Joint Planning and Development Office: Actions Needed To Reduce Risks With the Next Generation Air Transportation System," February 12, 2007.

[6] National Research Council of the National Academies, "Assessing the Research and Development Plan for the Next Generation Air Transportation System," July 31, 2008.

a year or more for the documents to be effective tools for driving agency budgets, setting priorities, and managing research efforts.

FAA and its partner agencies need to address several fundamental issues related to policy questions and research priorities to ensure that research and development efforts are aligned and successfully transferred to the NAS. An internal JPDO assessment identified 27 single agency and cross-agency disconnects or gaps that will materially affect the cost and timeframes for developing NextGen. These include the following areas.

Development of Advanced Software and Flexible Airspace: The National Aeronautics and Space Administration (NASA) is taking the lead role in developing new software algorithms that will help boost controller productivity and provide more flexible airspace; these are key elements and cost drivers for NextGen. As we noted in our February 2007 report, NASA is spending less on aeronautics research than in the past and is concentrating on "fundamental research" instead of prototype development. This is in sharp contrast to NASA's support of FAA's Free Flight Phase 1 initiative, which introduced new automated controller tools at select locations in the 1998 to 2002 timeframe. FAA's Research Engineering Development Advisory Committee[7] suggested that $100 million would be needed by FAA annually to accommodate changes in NASA investments and address this gap.

To address this concern, we recommended that FAA assess the maturity of NASA research and develop a contingency plan for how to conduct, manage, and pay for this research and development. FAA concurred and has established "research transition teams" to determine how best to advance NASA research.

The JPDO's internal assessment showed that NASA research is fairly well-aligned. However, NASA research efforts fall short with respect to integrating weather information into new systems, validating new software algorithms, linking airport arrivals and departures, and creating flexible airspace in the vicinity of airports. Further, fundamental questions about how requirements should be allocated to ground automation systems and the cockpit remain unresolved.

NASA officials told us that they will consider advancing some NextGen research to a higher technology level on a case-by-case basis. Notwithstanding these efforts, the transition from NASA research to prototype development and ultimately implementation remains a key watch item and cost driver. We are assisting the NASA Office of Inspector General in examining NASA's contribution to NextGen, including the management of research projects and contracting vehicles. The NASA Office of Inspector General expects to complete its report later this year.

Surveillance and Airspace Security: FAA is developing new systems, such as ADS–B, that will decrease reliance on ground-based radar and instead rely on onboard systems to broadcast aircraft positions. While the new systems will be useful to DOD and DHS, they will not meet all of their needs with respect to identifying and monitoring unlawful flights. DOD is funding research and development for future radar and surveillance sensors. The JPDO assessment cautioned that surveillance and security efforts are not as synchronized as they should be and stated that the best methods for meeting the needs and requirements of various agencies have yet to be determined. Without networking and integration among different agencies, there is potential for duplicative efforts, gaps in airspace coverage, and inefficiency that could impede the integrated surveillance and security capabilities envisioned for NextGen.

Net-Centric Operations and Sharing Information: A key element of NextGen is sharing a wide range of information (weather information, flight data, and aircraft position) securely and seamlessly. The JPDO is seeking to leverage DOD's extensive experience in this area, and demonstrations have shown the potential for linking various agency systems—both old and new—for sharing data. However, several factors are impeding progress. As the JPDO's internal assessment points out, plans, standards, and execution paths for FAA, DOD, DHS, and the Department of Commerce to connect various networks do not yet exist. Further, no cross-agency plan exists for integrating agencies' net-centric efforts to ensure seamless operations.

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[7] The Research, Engineering and Development Advisory Committee was established in 1989 and advises the Administrator on research and development issues and coordinates the FAA's research, engineering, and development activities with industry and other Government agencies. The committee considers aviation research needs in air traffic services, airport technology, aircraft safety, aviation security, human factors, and environment and energy.

Development of New Weather Tools and Concepts: The Department of Commerce has the lead role in developing the "4–D Weather Cube,"[8] which is expected to provide a single authoritative source for weather observations and analysis. This tool is also expected to provide a common picture of weather for all airspace users.

The JPDO's assessment found that there is disagreement on synchronizing weather observations, forecasts, and dissemination efforts. This threatens current plans to implement the 4–D Weather Cube in the 2013 timeframe. The assessment also noted that several policy and funding issues need to be addressed; specifically, most of the Department of Commerce efforts that JPDO expects to rely on are not funded. In addition, there is disagreement on the legal responsibilities for providing weather information and requirements for new weather systems.

Human Factors for Controllers and Pilots: As we have noted in the past, a focused human factors research effort for NextGen is needed to ensure that new concepts and technologies can be safely implemented. This is important because the NextGen concept of operations calls for significant changes to the roles of controllers and pilots. We note that insufficient attention to human factors with STARS resulted in significant cost increases and schedule slips. Key issues for NextGen human factors research focus on what can reasonably be expected from new automation systems and cockpit displays.

This remains a major risk area for NextGen. The JPDO assessment noted a lack of linkage between planned human factors research and key issues that needs to be resolved. This includes the impact of highly automated systems on controllers. We are concerned because there is no cross-cutting, interagency plan for identifying and addressing NextGen human factors issues that (1) establishes an agreed-upon set of initial focus areas for research, (2) inventories existing facilities for research, and (3) capitalizes on past and current research.

Observations on FAA's Recent Reorganization of NextGen Efforts

The question of whether or not FAA is properly organized to implement NextGen is important because it will drive the success of the effort. As we have previously noted, the development of NextGen cuts across all lines of the ATO. It also involves FAA's airport and certification offices. Further, NextGen efforts will need to be managed as integrated "portfolios" to achieve expected benefits. We believe that clear lines of accountability and budget authority will be essential for managing NextGen.

The overall governance of the NextGen effort has been the subject of debate, and stakeholders have raised concerns that FAA is not properly organized to manage or execute a multi-billion-dollar effort. Furthermore, there has been—and continues to be—friction between the ATO and JPDO, which is due in part to vastly different planning horizons. The ATO is an organization that operates constantly but has a short planning horizon. The JPDO, on the other hand, is focused on introducing cutting-edge technologies and transforming the NAS by the 2025 timeframe. It will be important to reconcile these differences to successfully implement NextGen.

In May 2008, FAA announced a reorganization of its NextGen efforts, which included establishing a Senior Vice President for NextGen and Operations Planning within the ATO; this individual reports to the FAA Chief Operating Officer. FAA is also establishing an office for NextGen Implementation and Integration to support the Senior Vice President.

Under this framework, the JPDO now reports to the Senior Vice President for NextGen and Operations Planning. In the past, the JPDO reported directly to the FAA Administrator and the Chief Operating Officer. While FAA believes the change will help move NextGen concepts closer to implementation, it could also give the appearance that the JPDO has been reduced in stature and importance.

This recent reorganization is still undergoing changes, and it is too early to determine its effectiveness; however, we do have the following initial observations:

- First, the roles and responsibilities of the JPDO and the ATO office for NextGen Implementation and Integration are not clearly defined. According to FAA, the JPDO will focus on long-term planning and interagency cooperation while the ATO will focus on more short-term efforts and other implementation issues. However, it will be difficult to establish clear demarcation lines because implementing NextGen capabilities depends heavily on modifying existing modernization projects. Both offices will have budget functions, considerable modeling and simulation capabilities, and architecture staffs. Because

[8] The 4–D Weather Cube is expected to be a distributed database on weather observations for the continental United States. It is expected to include observations with respect to latitude, longitude, altitude, and time.

both offices will help to shape research and development plans, it will be important to establish clearly defined roles and responsibilities.

- Second, while the ATO's Senior Vice President for NextGen and Operations Planning will manage demonstration projects, other ATO Vice Presidents will manage major modernization projects considered to be essential platforms for NextGen. For example, the Vice President for En Route Services manages multi-billion-dollar efforts like ERAM and ADS–B. SWIM, however, will be managed by the Vice President for Technical Operations. Similarly, the Vice President for Terminal Services manages efforts to modernize controller displays and computer equipment located in the vicinity of airports. However, airports—which play a key role in NextGen—are managed by a different FAA office that is outside the ATO. Thus, budgetary authority for FAA modernization efforts remains fragmented across various offices.

  The Senior Vice President for NextGen and Operations Planning stated that she will be responsible for the integration and implementation of all NextGen elements even though most elements will be managed and executed by other ATO service units and lines of business. The NextGen and Operations Planning Office will rely on coordination and a commitment monitoring process across multiple areas. This approach, however, has not been fully implemented or tested for linking budgets and plans for diverse programs. Given the complex nature of NextGen development, FAA's approach to determining budget authority and managing interdependencies among legacy and new programs will be important watch items for this committee.

- Third, the new structure will be challenged to deal with complex, cross-cutting government issues. In our opinion, it will be difficult for an office within the ATO to work out agreements with DOD and DHS on major decisions affecting surveillance and airspace security.

It remains to be seen how DOD, NASA, Commerce, and other JPDO partner agencies will view the reorganization and how it will affect participation in NextGen efforts. FAA must clearly demonstrate that this change is neither a demotion for the JPDO nor a decrease in the Agency's commitment to a multi-agency approach for developing NextGen.

FAA will likely have to revisit the question of NextGen governance once it has a better picture of what will be required to develop and implement NextGen. As we have noted in the past, FAA will have to address other NextGen management issues, such as deciding whether a "lead systems integrator" will be needed to address the complex system engineering challenges in linking legacy and new systems.

We note that the House Reauthorization proposal (H.R. 2881) would establish an Associate Administrator for NextGen who would report directly to the FAA Administrator. How to organize FAA is a policy call for Congress, but we believe such an approach has merit as the cross-cutting nature of the NextGen effort will require close coordination of multi-billion-dollar investments from industry and other federal agencies.

Several Actions Are Needed Going Forward To Help Focus NextGen Efforts

Moving forward with NextGen will be a central issue for the next Congress and a top management challenge for the new administration. FAA is at a critical juncture with its NextGen efforts and needs to set expectations and budgetary priorities.

This chapter in air traffic modernization is different from previous efforts because NextGen concepts rely heavily on airspace users to invest billions of dollars in new avionics. The current state of the airline industry requires FAA to determine where investments in new technology can have the most benefit in reducing costs and alleviating delays, the underlying causes of consumer dissatisfaction with air travel.

We have made numerous recommendations to FAA and the JPDO to help them move forward with NextGen. These include developing an interim architecture, assessing the skill mix with respect to necessary systems integration and contracting, and focusing human factors research to ensure concepts can be safely implemented. FAA agreed with all of our recommendations and has begun addressing our concerns. At this time, we believe FAA needs to take the following actions.

- **Establish priorities and reflect them in budget requests and plans.** It remains difficult for decision-makers to determine what to invest in first from the wide range of operational improvements in NextGen planning documents. FAA has taken some steps to begin shaping priorities, such as integrating weather data into new systems. Nevertheless, more work is required to set priorities and identify the proper sequencing of efforts. FAA should provide

this committee with a clear understanding of how it will prioritize research and development, how it is addressing various research gaps, and how it will update priorities when research results become available or when national priorities change.

- **Develop a strategy for transferring technology.** As we noted in our February 2007 report, the movement of technology from one organization to another is critical given the JPDO's mandate. However, the JPDO's internal assessment noted that mechanisms and funding to transition research into the NAS may be inadequate. To address technology transfer issues with NASA, FAA has established "research transition teams." FAA has not, however, formed similar teams for other agencies, such as the Departments of Commerce and Defense. JPDO officials pointed out that "entrance and exit" criteria with clearly defined hand-off points for research projects would aid in determining what it will take to transition new concepts and technologies into daily operations.
- **Clearly define the roles of the ATO and JPDO and focus the considerable resources at the Agency's disposal.** Agency resources that are key to NextGen development include the MITRE Corporation (FAA's federally funded Research and Development Center), the NextGen Institute[9] (a mechanism for the private sector to cooperate with the JPDO on NextGen), and RTCA (an industry/Government forum that functions as Federal Advisory Committee for FAA). Because there is considerable potential for duplicative efforts, FAA officials agree that it is an appropriate time to re-examine work plans, assess resources, and review roles of these various organizations.

  All of these organizations can help validate NextGen concepts and establish requirements. Understanding the impact of many changes will require extensive analysis, modeling, simulation, and work with airspace users to examine trade-offs and assess benefits. Clearly defined roles for each of these organizations would help better define investment decisions and foster consensus among stakeholders.
- **Focus attention on airport issues and the relief that various NextGen technologies can provide to already congested airports in major metropolitan areas, like New York and Chicago.** Reducing congestion at airports should be a top priority for FAA. An important metric for NextGen is to what extent FAA can improve *airport arrival rates* under various weather conditions. FAA recognizes the importance of this and is shifting resources to this issue. However, FAA's efforts to examine "high density operations" are in the very early stages, and planning documents and budget requests thus far do not detail how individual NextGen systems can specifically boost airport capacity and reduce delays. Decision-makers and stakeholders need to know what elements—ADS–B, new routes, and data link communications for controllers and pilots—are essential for improving capacity at already congested airports.
- **Develop a realistic plan for implementing ADS–B and realizing the air-to-air benefits of the new technology.** This is important because FAA has a contract in place and has published a Notice of Proposed Rule-making (NPRM). The NPRM calls for users to equip with ADS–B—Out in the 2020 timeframe. FAA has received comments from 177 organizations or individuals about the details of the NPRM. While most agree that ADS–B is an important part of the future, some raised concerns about requirements, the cost of equipage, and lack of clear benefits—all legitimate issues that will need to be resolved. FAA will likely have to make significant changes to its plans for implementing ADS–B in the United States.
- **Assess "implementation bandwidth" and develop transition benchmarks.** FAA's ability to implement multiple capabilities in a given time period needs to be assessed. There are limits to what can be accomplished given the scope of change envisioned and efforts currently underway. For example, FAA has staggered key NextGen capabilities, such as data link communications, to wait for the completion of ERAM in the 2012 timeframe. FAA must clearly identify how various efforts will be sequenced. Further, FAA and in-

[9] The NextGen Institute was established in March 2005 by joint agreement between the National Center for Advanced Technologies (NCAT) and the Federal Aviation Administration "as the mechanism through which the JPDO will access private sector expertise, tools, and facilities for application to NextGen activities and tasks."

dustry need realistic transition benchmarks that point to when new training (for controllers and pilots), equipment (new avionics and ground systems), and procedures need to be in place at specific locations.

Mr. Chairman, this concludes my statement. I would be happy to answer any questions that you or other Members of the Committee might have.

EXHIBIT. MECHANISMS FOR RESOURCE ALIGNMENT

Mechanism	Status
NextGen Enterprise Architecture (Blueprint)	The JPDO published the first version of the NextGen Enterprise Architecture (EA) in April 2007. In June 2007, the JPDO released version 2.0. An October 2007 MITRE Corporation assessment of the EA highlighted unresolved technical issues and gaps between the NextGen EA and the NextGen concept of operations. MITRE found that, in most cases, information in the NextGen EA remained at too high of a level to be effective.
Memorandum of Understanding (MOU) Between NextGen Partner Agencies	The MOU formalizes agreements among partner agencies to achieve NextGen. In addition, it commits the agencies to provide resources and to establish procedures to align budgets and plans. The effort to complete the MOU began in 2004 and was finally signed by all partner agencies in June 2008. Emphasis must now shift to gaining approval for the MOU annex, which will establish processes for reporting agency contributions, making decisions, and clarifying matters relating to private sector involvement in NextGen activities.
NextGen Research and Development Plan (R&D)	The August 2007 plan represents the first effort between the JPDO and the partner agencies to identify NextGen research and development efforts. The analysis, debate, and negotiation that have culminated in this plan represent a baseline to refine the needs of this complex effort. In the coming months, the JPDO plans to fully incorporate and synchronize the R&D plan with the NextGen Integrated Work Plan and the EA. The R&D plan is a work in progress, and next steps focus on establishing priorities and addressing airport issues. We think future versions should also include funding data.
NextGen Integrated Work Plan (IWP)	The current IWP, version 0.2, reflects the NextGen vision as defined by the NextGen Concept of Operations (ConOps) and the NextGen Enterprise Architecture. JPDO officials acknowledge that the IWP does not fully describe operational concepts and functions of NextGen, and the JPDO plans to continue to refine the document over the next few years. These refinements will include identifying priorities, benefits, risks, costs, and technology maturity, which will be required to support investment decisions. The JPDO plans to release another version of the IWP, version 1.0, in September 2008. This version is expected to include an avionics "road map" that will identify the expected aircraft capability and avionics packages envisioned for NextGen.
Concept of Operations (ConOps)	The NextGen ConOps provides a common vision for how NextGen will operate in 2025 timeframe. It forms a baseline that is intended guide the development of policy and research agendas needed to move forward with NextGen. The JPDO has released the ConOps for stakeholder comment. The updated version of the ConOps is planned for release in FY 2009.
Consolidated Multi-Agency Office of Management and Budget Exhibit 300 for NextGen	The current Office of Management and Budget Exhibit 300 is the first effort to combine the portfolios of capital, research, and development investments of all partner agencies required to support NextGen from FY 2009 to FY 2013. This document is still evolving and does not yet capture DOD's potential contributions to NextGen. The JPDO is working to more accurately reflect the efforts of all partner agencies for future budget submissions.

BIOGRAPHY FOR CALVIN L. SCOVEL III

Calvin L. Scovel III is the Inspector General of the U.S. Department of Transportation (DOT).

Mr. Scovel was nominated by President Bush on July 13, 2006, confirmed by the Senate on September 29, 2006, and sworn in on October 27, 2006.

Scovel joined DOT after 29 years of active service in the U.S. Marine Corps, from which he retired as a Brigadier General. His last military assignment was as a senior judge on the U.S. Navy–Marine Corps Court of Criminal Appeals. He previously served as Assistant Judge Advocate General of the Navy for Military Justice, the principal advisor to the Secretary of the Navy and the Judge Advocate General on

all criminal justice policy matters. Mr. Scovel also commanded a military police battalion that provided all security and law enforcement services for Marine Corps Base, Quantico, Virginia.

Mr. Scovel served as senior legal advisor for the 4th Marine Expeditionary Brigade, which included all Marine amphibious forces in Operation Desert Storm, and later in a NATO exercise in Norway. He had previously served as legal advisor for a Marine amphibious unit deployed to the Western Pacific and Indian Oceans, where it conducted exercises in Japan, the Philippines, Kenya, and Australia.

He was prosecutor or defense counsel in 250 courts-martial that included charges of murder, rape, child sexual assault, and drug trafficking.

As an adjunct faculty member for the Defense Institute of International Legal Studies, Mr. Scovel led instruction teams in the rule of law and civilian control of the military for senior civilian and military officials in Honduras, Mauritius, Albania, and Serbia. Mr. Scovel, who was in the Pentagon on September 11, 2001, has received military awards including the Legion of Merit (four awards) and the Combat Action Ribbon.

Mr. Scovel received his Bachelor's degree from the University of North Carolina at Chapel Hill and his Juris Doctor degree from Duke University. He also received a Master's degree from the Naval War College.

Mr. Scovel and his wife, Cathy, have two sons: Carey, a 2006 graduate of Elon University who is a police officer in Charlotte, North Carolina, and Thomas, a midshipman at the U.S. Naval Academy.

Mr. Scovel is the sixth person to serve as DOT Inspector General. The Office of Inspector General (OIG) was established by law in 1978 to provide the Secretary and Congress with objective and independent reviews of the efficiency and effectiveness of DOT operations and activities.

The OIG carries out its mission by issuing audit reports, evaluations, and management advisories with findings and recommendations to improve program delivery and performance. In Fiscal Year 2007, OIG issued 81 audit reports, which identified more than $900 million in financial recommendations.

By statute, the Inspector General also conducts investigations into whether federal laws and regulations were followed and must report suspected civil and criminal violations to the Attorney General. In Fiscal Year 2007, OIG investigations resulted in 112 indictments, 142 convictions and $183 million in fines, restitutions and recoveries.

Chairman GORDON. Thank you. Dr. Kaminski, you are next.

STATEMENT OF DR. PAUL G. KAMINSKI, CHAIRMAN AND CEO, TECHNOVATION, INC.; AIA MEMBER OF NEXTGEN INSTITUTE MANAGEMENT COMMITTEE

Dr. KAMINSKI. Thank you, Mr. Chairman. My name is Paul Kaminski. I am the Chairman and CEO of Technovation Incorporated, but I am here today representing the Aerospace Industries Association.

Since January of this year I have been representing AIA on something called the Institute Management Council, which works with the Next Generation Institute that oversees the industry participation in the JPDO. Prior to that I had served on a Senior Review Committee for the JPDO, having been appointed by then Secretary Mineta.

I last testified before this committee in June of 2006, when I chaired the National Research Council's first decadal survey of civil aeronautics technology. In that testimony I said that the U.S. Air Transportation System is a key contributor to the economic vitality, public well-being, and national security of the United States. I strongly endorsed the need to improve our Air Transportation System then, and I believe that need is even more important today considering issues such as the high cost of fuel and our growing concerns about the environment.

NextGen, with its capacity, efficiency, energy, environmental, and safety benefits, must be a strong and urgent priority for this

nation. Marion Blakey, former FAA Administrator and now President of the Aerospace Industries Association, sought my assistance in the IMC in January of this year because she knew of my strong commitment to improving and actually executing on NextGen, and she also was aware of the experience I had serving as Under Secretary of Defense dealing with the development and acquisition of very large and complex systems such as NextGen.

Working with AIA I have developed a proposal to deal with many of the issues that have been raised in previous statements and accelerate the development, acquisition, and integration of the NextGen System. This approach is based on the techniques that are used to accelerate the development and fielding of our first stealth system, the F–117 in the Department of Defense.

I found this method to be very effective in dealing with large, complex systems that depend upon the effective integration of numerous enabling technologies and complex procedures. I am prepared to address this in some more detail in a briefing which follows if there is interest or in pursuing that further because it deals with many of the questions that you posed to me.

But before getting into that detail, I would like to highlight a few other points briefly. One, system engineering and integration is going to be critical to the success of NextGen, and that is the lynchpin of the proposal that I have developed. I expect our nation's efforts on NextGen to continue for a long time as new technology enablers will continue to appear, and we must continue to consider the costs and benefits of continuing advancing technology.

We must also consider the cost and benefits of maintaining legacy systems that will become obsolete over time. In a sense, NextGen will be like painting the Golden Gate Bridge. When we finish the north end, it will be time to come back around to the south end and begin again. So we should prepare a foundation with this extended process in mind. We are going to be at this on a continuing basis.

But that doesn't mean we shouldn't move with dispatch to begin to implement this capability. The AIA proposal that I have made allows us to begin now to do what I describe as build a little and test a little, layering and linking capabilities. It will help us to better define and prioritize the essential NextGen R&D for both the FAA and for our JPDO partner agencies. It will also provide critically-important domain experience to key personnel in government and industry. We need this personal experience base to be able to execute this kind of a system.

This domain experience in government industry is a requisite for the system engineering and integration required in such large-scale and complex programs. I recently chaired another national research council review, this one on the subject of system engineering, which clearly recognized the importance of strengthening system engineering skills to avoid the problems associated with the acquisition of large and complex systems that we have seen in DOD and other agencies.

The good news here is that the FAA in an effort led by Vicki Cox has initiated a program to begin to enhance our system engineering education, a good first step, more yet is required.

The third point, AIA believes that the JPDO role as an honest broker with partner agencies can be enhanced by the recent FAA restructuring. As planning melds into implementation, the operating agency, with all responsibility and at the end of the day all the accountability, will be the FAA. And JPDO-participation agencies need to be engaged and ensured that their work will be closely integrated and aligned with key milestones and measured under a new structure.

And we have two recommendations for metrics for success. The first is implementation of this incremental plan that I am prepared to describe in more detail. The second is that FAA and industry, possibly through our Institute Management Council, develop NextGen measures of success and milestones. For NextGen we believe the industry does have valuable process expertise as well as subject matter expertise to offer.

We also note the recent developments in energy and its impact on NextGen can't be ignored. But consideration of NextGen benefits must be expanded beyond capacity improvements to include NextGen's energy and environmental benefits.

AIA is encouraged at FAA's response in this arena, as they have begun integrating modeling of energy and environmental consequences such as fuel burn and noise, with the modeling of aircraft operations.

We also have an idea for incentivising early NextGen equipage. With the significant energy and environmental benefits of NextGen we believe Congress should consider energy tax credits for early NextGen equipage. We do it for cars, home improvements, and appliances. Why not aviation, at least for early equipage?

And finally, while FAA can speak more authoritatively about this, we believe the lack of an FAA budget will seriously hamper NextGen development and progress. And industry is on record as strongly endorsing the integration of NextGen with day-to-day air system operations and JPDO long-term planning.

Because AIA members populate all of the working groups and co-chair seven of our nine groups, we are in a good position to evaluate FAA restructuring. Our members uniformly support this change, for it keeps the work plan where it belongs, closer to the implementing agency, and keeps longer-term planning within divisionary construct of JPDO.

[The prepared statement of Dr. Kaminski follows:]

PREPARED STATEMENT OF PAUL G. KAMINSKI

Good afternoon Chairman Gordon, Ranking Member Hall, and Members of the Committee. Thank you for the opportunity to testify before you today. My name is Paul Kaminski. I am the Chairman and Chief Executive Officer of Technovation, Inc., and a senior partner in Global Technology Partners—but I am here today representing the Aerospace Industries Association (AIA). Since January, I have been representing AIA on the Institute Management Council of the NextGen Institute that oversees industry participation in the JPDO.

Representing nearly 300 manufacturing companies with more than 642,000 high-wage, highly skilled employees, AIA operates as the largest aerospace trade association in the United States across three sectors: civil aviation, space systems, and national defense. AIA member companies export 48 percent of their total output and they routinely post the Nation's largest manufacturing trade surplus, at a level approaching $60 billion in 2007. The aerospace industry continues to look to the future, investing heavily in R&D and spending more than $50 billion over the last 15 years.

I last testified before you in June of 2006 when I chaired the National Research Council's Committee on the Decadal Survey of Civil Aeronautics. Then I said: "The U.S. air transportation system is a key contributor to the economic vitality, public wellbeing, and national security of the United States." I endorsed the need to improve our air transportation system then, and I believe that need is even more important today with the high cost of fuel and the growing concerns about the environment.

NextGen—with its capacity, efficiency, energy, environmental and safety benefits—must be a strong and urgent priority for the Nation.

Marion Blakey, former FAA Administrator and now President of AIA, sought my assistance with the IMC in January of this year because of my commitment to improving NextGen, and my experience in the development and acquisition of large, complex systems in the Department of Defense.

Working with AIA, I proposed a method to accelerate the development, acquisition, integration and implementation of the NextGen System based on the techniques that we used to accelerate development and fielding of the F–117 program. This method is very effective in dealing with large, complex systems that depend upon effective integration of numerous enabling technologies and complex operating procedures.

But before I get into detail about this AIA proposal for development and acquisition, I want to highlight a few other important points:

1. Systems engineering and integration will critical to the success of NextGen—and that's the lynchpin to this proposal I'll discuss shortly. I expect our nation's efforts on NextGen to continue for a long time, as new technology enablers will continue to appear and we must consider the cost and benefits of advanced technology within our systems engineering foundation. We must also continue to consider the cost and benefits of maintaining legacy systems that will become obsolete. In a sense, NextGen will be like painting the Golden Gate bridge—when we finish the north end, it will be time to come back and begin at the south end. So we should prepare the foundation with that extended process in mind. But that doesn't mean that we shouldn't move with dispatch.
2. This AIA proposal allows us to begin now to build a little and test a little, layering and linking capabilities. It will help to better define and prioritize the essential NextGen R&D for both FAA and JPDO partner agencies. It will also provide critically important "domain experience" to key personnel in both government and industry. This domain experience in both government and industry is a requisite for the systems engineering and integration required in large scale, complex programs such as NextGen. I recently chaired a National Research Council review of systems engineering which recognized the importance of strengthening systems engineering skills to avoid problems associated with the acquisition of large and complex systems. The FAA has recently initiated a program to enhance systems engineering education—a good first step.
3. AIA believes that JPDO's role as an honest broker with partner agencies can be enhanced by the recent FAA restructuring. As planning melds into implementation, the operating agency—with all the responsibility and, at the end of the day, all the accountability—is the FAA. JPDO participating agencies should be engaged and assured that their work will be more closely integrated, aligned with key milestones and measured under the new structure.
4. AIA has two recommendations for metrics of success—and they are not exclusive. The first—as I will elaborate soon—is implementation of NextGen incremental leave-behind capabilities using a rigorous implementation schedule. Second, we suggest that FAA and industry—possibly through the IMC—develop NextGen measures of success and milestones. For NextGen, industry has valuable process expertise, as well as subject matter expertise, to offer.
5. Recent developments with energy and its impact on NextGen cannot be ignored. The consideration of NextGen benefits must be expanded beyond capacity improvement to include NextGen's energy and environmental benefits. AIA is encouraged at FAA's quick response, as they have begun integrating modeling of energy and environmental consequences—such as fuel burn and noise—with modeling of aircraft operations and systemwide operations. This will help quantify energy and environmental benefits of NextGen improvements to strengthen the NextGen business case.
6. We also have an idea for incentivizing early NextGen equipage. With the significant energy and environmental benefits of NextGen, Congress should con-

sider energy tax credits for early NextGen equipage. We do it for cars, home improvements and appliances, why not aviation—at least for early equipage?

7. While FAA can speak more authoritatively about this, lack of a new FAA budget will seriously hamper NextGen development and progress. And industry is on record as strongly endorsing the integration of NextGen with day-to-day air system operations and JPDO long-term planning. Because AIA members populate all of the working groups and co-chair seven of the nine groups, we are in a good position to evaluate the FAA restructuring: Our members uniformly support this change for it keeps the work plan where it belongs—closer to the implementing agency—and keeps longer-term planning within the visionary construct of JPDO.

Now, to discuss how we can accelerate the transition from NextGen system concepts and R&D to implementation. See attached briefing charts.

AEROSPACE INDUSTRIES ASSOCIATION

How to Accelerate NextGen? What Needs to be Done

Dr. Paul Kaminski

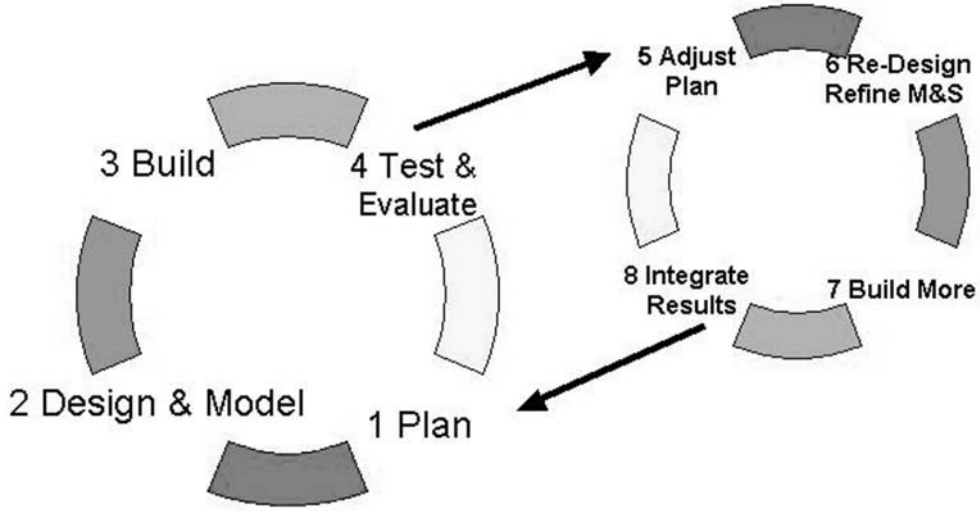
IMC & ExComm Member
Representing AIA

September 11, 2008

Essential Modifications

- NextGen Foundational Programs Need Near-Term Demos linked with Modeling & Simulation and Validated by Testing
- The Demos can then be Expanded and Extended in an Integrated Environment
- Begin Now with Operational Demonstrations (Building on Existing FAA Test Beds) with Stay Behind Capabilities, then Replicate & Integrate
- Build Acquisition & System Engineering Base- People gain domain experience at test bed demonstration locations

Iterative M&S Cycle



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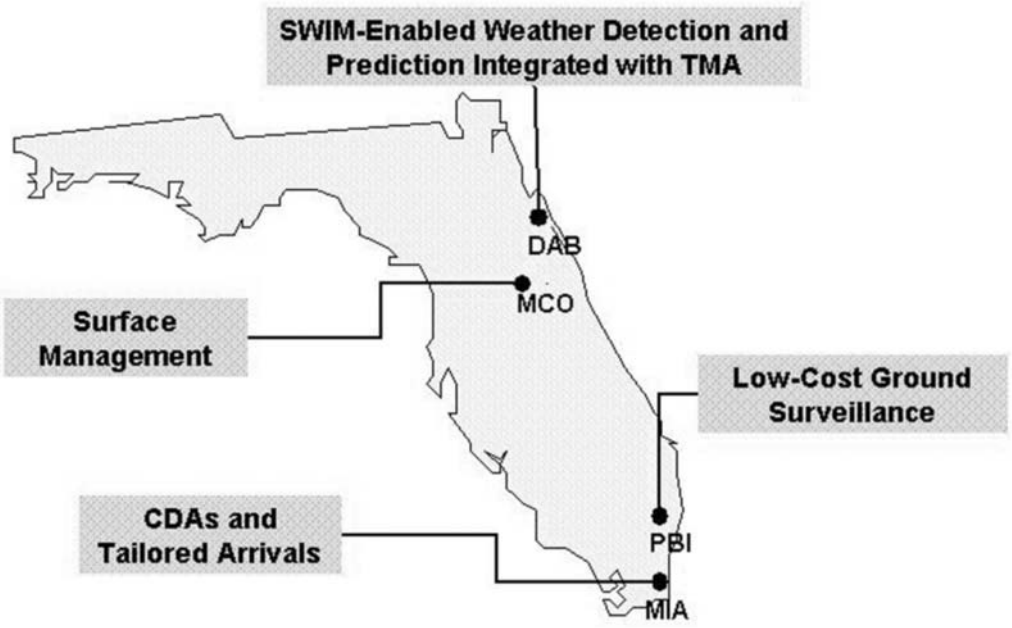
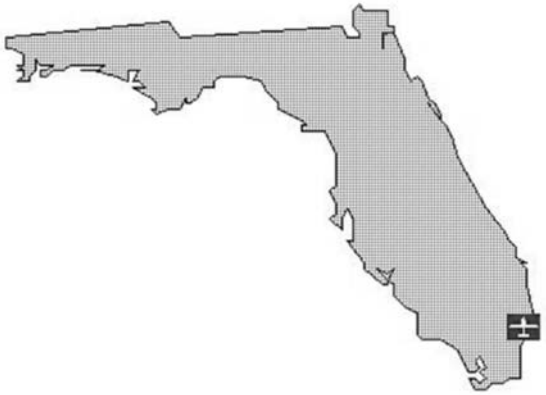
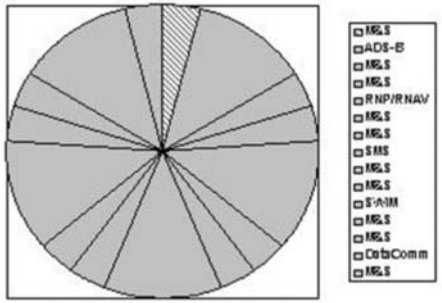
FAA Test Beds & Demonstrations



Initial ADS-B Roll-Out Capability

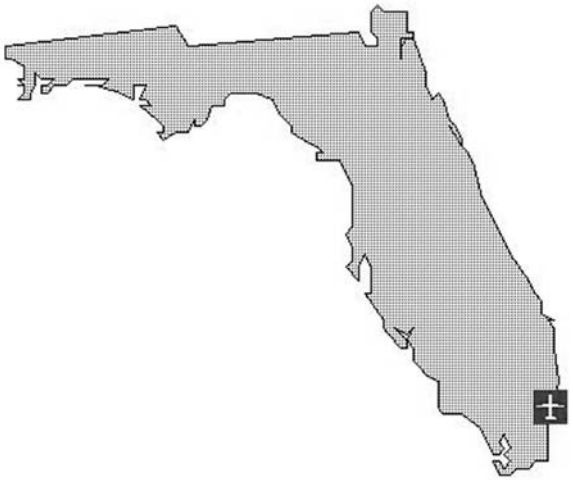
Notional – Not Necessarily choosing MIA

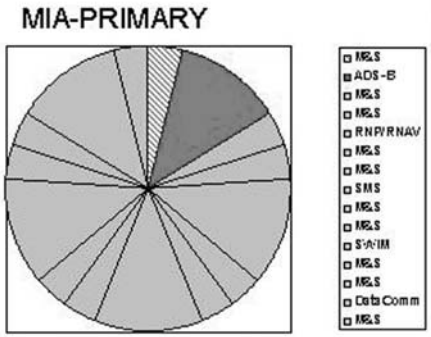




At this stage the M&S preparation to demonstrate ADS-B is represented in the shaded slice.

ADS-B Demonstration

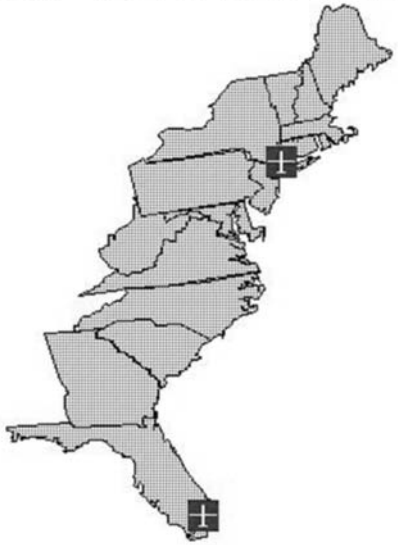


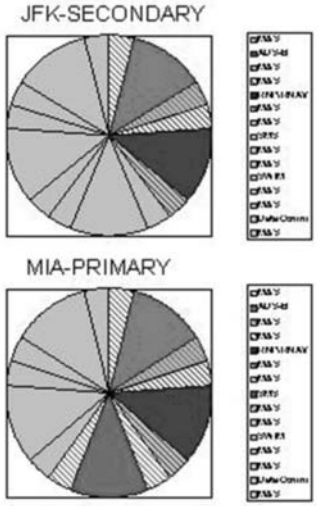


The large slice is representing the actual ADS-B demonstration.

NOTIONAL

Further Continued Integrated Iterations

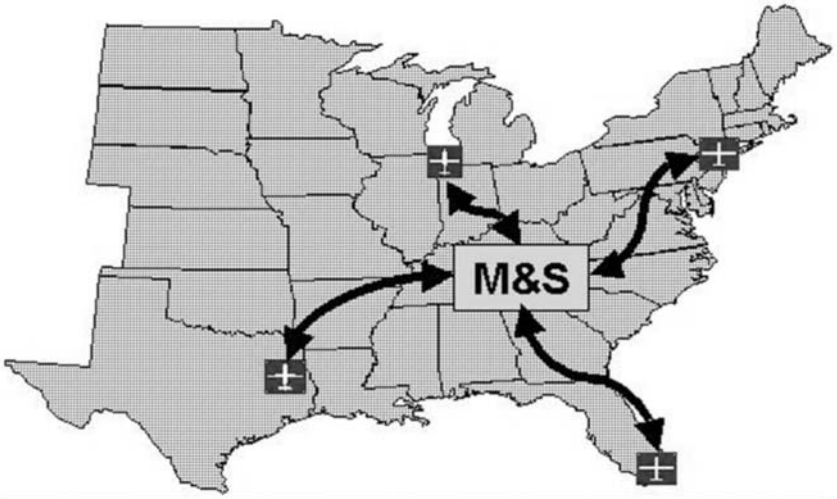




The primary box shows continued M&S with additional technologies while we begin implementing foundational results at a new test bed location.

NOTIONAL

The Collective M&S is a Key Enabler of Sound System Engineering



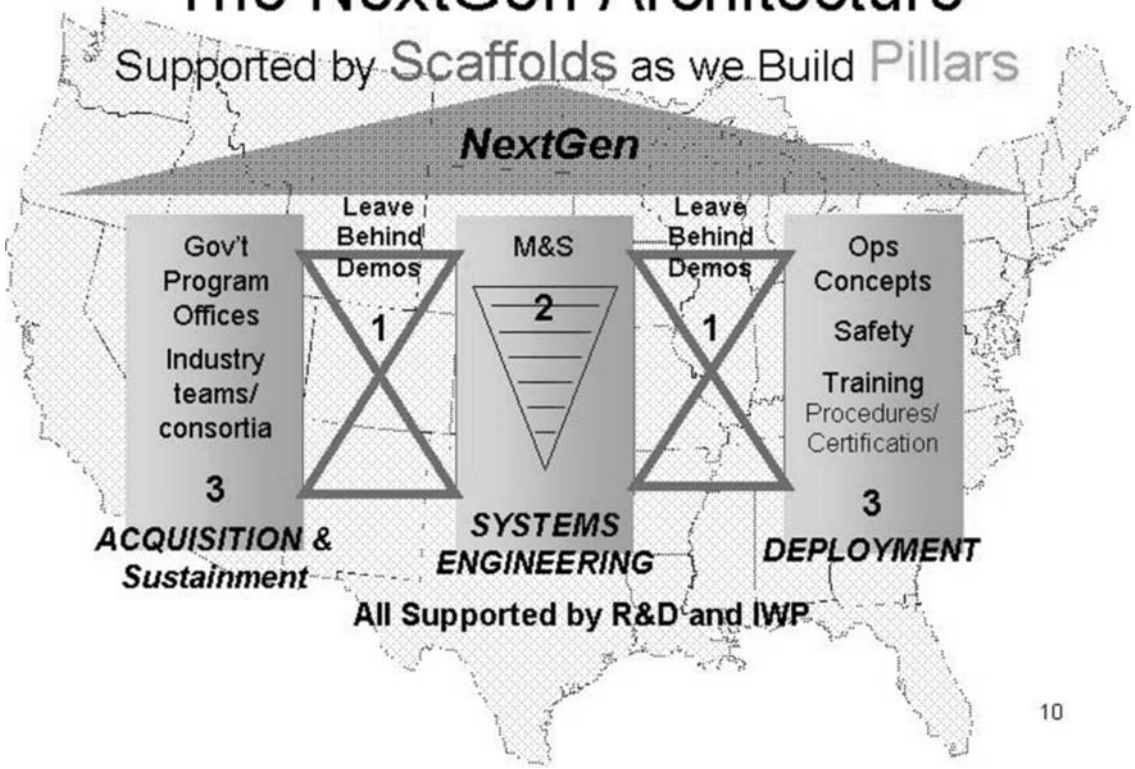
Once this is achieved the Strategic System Engineering Model will be Open to All Stakeholders.

Why Modeling & Simulation

- M&S Provides the Foundation for Systems Engineering Needed to Support Acquisition & Link to Implementation
- M&S Will Help Us Establish Priorities for Achieving the Best Payoff, and Help Define Policies & Procedures to Enhance Safety, Security and Operations
- Using Iterative M&S Enables Systematic Improvements, Promotes a Common Understanding of Complex New Capabilities, their Value Added, and Mutual Interaction
- M&S which is validated by testing is Key to Demonstrating the Value Proposition and Linking Incremental Improvements to the Business Case
- Data From M&S Supported By Demos Will Yield the Rationale and Business Case to Replace Unnecessary Legacy Systems

The NextGen Architecture

Supported by Scaffolds as we Build Pillars



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What's Needed to Execute?

- Strategic Systems Engineering Foundation (Enabled by M&S) To Refine Operational Planning & Requirements, Set Priorities, Develop System Specs, & Support Deployment Planning
- Systems Acquisition Experience and Discipline to Enhance JPDO Planning and FAA Implementation Processes
  - Systems Acquisition/Integration Management Expertise Needed to Manage JPDO govt./industry Working Groups and Mature IWP and Modeling & Simulation (M&S) Architecture
  - Systems Acquisition Manager Assigned Under FAA ATO/COO With Sub-ordinate Program Managers For Major Programs
    - Consortia and individual supporting industry contractors to implement NextGen (ADS-B contract consortium a good example)
- Begin now with operational demonstrations of foundational technology programs with stay behind capabilities, then replicate

In Conclusion, We Need:

- To Build the "Scaffolds" (Demonstrate and Model the Applications Enabled by Foundational Programs in an Integrated Approach) To Support the NextGen Vision as the First Step
- Then Strengthen the Three "Pillars"
  - System Engineering Supported by Robust M&S Capability to Support the Other 2 Pillars, Refine the Architecture & Integrate Technologies
  - System Acquisition & Integrated Management at FAA and Other Implementing Agencies
  - Deployment Planning to Include Operational Concepts, Safety, Procedures, Training & Security

Backup Charts

Need Consensus on Selection Criteria for Near -Term Demos

Some Suggested Criteria

- Capacity Enhancing
- More Energy Efficient
- Improved Safety/Security
- Environmentally Sound
- Implementable in the Next 5 years
- Favorable Benefits/Costs Ratio

Demos Provide Means To Link Foundational Programs With Enabled Applications & Criteria

Foundational Programs

- ADS-B
- RNP/RNAV
- Surface Management System (SMS)
- SWIM
- DataComm

Enabled Applications

- CDAs/Tailored Arrivals
- Closely Spaced Parallels
- CDTI assisted approaches

Criteria

- Capacity Enhancing
- More Energy Efficient
- Improved Safety/Security
- Environmentally Sound
- Implementable in the Next 5 years
- Favorable Benefits/Costs Ratio

Creating Deliverable in 2008

(Notional Example)

- Take the FAA Southern Florida Initiative and lay down ADS-B with RNAV/RNP Iteration
- Use Demo to Assess Benefits & Limitations of ADS-B and RNAV/RNP to Increase Capacity & Efficiency at MIA
- Capture Demonstration Data and Publish Public Report of Near Term NextGen Foundational Technologies that Can Make a Difference

BIOGRAPHY FOR PAUL G. KAMINSKI

Paul G. Kaminski is Chairman and CEO of Technovation, Inc., a consulting company dedicated to fostering innovation, and to the development and application of advanced technology. He is also a Senior Partner in Global Technology Partners, a consulting firm specializing in business strategy and investments in technology, defense and aerospace-related companies.

Dr. Kaminski served as the Under Secretary of Defense for Acquisition and Technology from October 3, 1994 to May 16, 1997. He was responsible for all Department of Defense (DOD) research, development, and acquisition programs. He also had responsibility for DOD logistics, environmental security, international programs, the defense industrial base, and military construction. The annual budget for these entities exceeded $100 billion.

Dr. Kaminski has had a continuing career involving large program management, and the development and application of advanced technology in both the private and public sectors. He served as Chairman and Chief Executive Officer of Technology Strategies and Alliances, a technology oriented investment banking and consulting firm. He has served as Chairman of the Defense Science Board and was a member of the Defense Policy Board. In addition, he has served as a consultant and advisor to a wide variety of government agencies and as a director and trustee of several defense and technology oriented companies.

His previous government experience includes a 20-year career as an officer in the Air Force. During 19811984, he served as Director for Low Observables Technology, with responsibility for directing the development, production and fielding of the major "stealth" systems (e.g., F–117, B–2). Prior to that, he served as Special Assistant to the Under Secretary of Defense for Research and Engineering. He also led the initial development of a National Reconnaissance Office space system and related sensor technology. Early in his career, he was responsible for test and evaluation of inertial guidance components for the Minuteman missile and terminal guidance systems for our first precision guided munitions.

Dr. Kaminski is a member of the National Academy of Engineering, a Fellow of the Institute for Electrical and Electronics Engineers, a Fellow of the American Institute of Aeronautics & Astronautics, and a Senior Fellow of the Defense Science Board. He is Chairman of the Board of both Exostar and HRL Labs, and a Director of Bay Microsystems, CoVant Technologies, General Dynamics, and RAND. He serves as an advisor to the Johns Hopkins Applied Physics Lab, LynuxWorks, Inc., and MIT Lincoln Laboratory. He is a member of the Senate Select Committee on Intelligence Technical Advisory Board, the National Reconnaissance Office Technology Advisory Group, the FBI Director's Advisory Board, and the Atlantic Council. He has authored publications dealing with inertial and terminal guidance system performance, simulation techniques, Kalman filtering and numerical techniques applied to estimation problems.

Dr. Kaminski has received the following awards: National Medal of Technology 2006, Department of Defense Medal for Distinguished Public Service (3 awards), Defense Distinguished Service Medal, Director of Central Intelligence Director's Award, Defense Intelligence Agency Director's Award, Legion of Merit with Oak Leaf Cluster, Air Force Academy 2002 Distinguished Graduate Award, the International Strategic Studies Association Stefan T. Possony Medal for Outstanding Contributions to Strategic Progress through Science and Technology, the AOC Gold Medal, the Netherlands Medal of Merit in Gold, the French Republic Legion d'Honneur, and the Air Force Systems Command Scientific Achievement Award. He has been recognized as a Pioneer of National Reconnaissance and a Pioneer of Stealth.

Dr. Kaminski was born in Cleveland, Ohio. He received a Bachelor of Science from the Air Force Academy, Master of Science degrees in both Aeronautics and Astronautics and in Electrical Engineering from the Massachusetts Institute of Technology, and a Ph.D. in Aeronautics and Astronautics from Stanford University. He and his wife, Julie, have two children, and four grandchildren.

Chairman GORDON. Thank you, Dr. Kaminski, and we welcome additional information that you want to provide us. We will put that for our review, and we will also be having more informal type round-table discussions to follow up.

Dr. Waitz, you are next.

STATEMENT OF DR. IAN A. WAITZ, PARTNER DIRECTOR; JEROME C. HUNSAKER PROFESSOR OF AERONAUTICS AND ASTRONAUTICS; HEAD, DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dr. WAITZ. Chairman Gordon and Members of the Committee, thank you for the opportunity to comment on the status of NextGen with regard to impacts on the environment. I am the head of the Department of Aeronautics and Astronautics at MIT and Director of the Partnership for AiR Transportation Noise and Emissions Reduction, also known as PARTNER. I would like to note that I have also provided a more-detailed written statement.

At PARTNER, an FAA/NASA/Transport Canada-funded Center of Excellence, we focus on energy aviation and the environment. We have more than 50 graduate students working with faculty members at a dozen universities. More than 50 U.S. and international organizations collaborate with us and are represented on our advisory board.

In 2004, we wrote a report to Congress on aviation and the environment on behalf of the Secretary of Transportation and the Administrator of NASA. The report put forward a national vision for aviation in the environment that specifies absolute reductions in significant health and welfare impacts from aviation noise and air quality and reduced uncertainty in understanding other emissions or other impacts such as climate.

Since 2004, when we wrote the report, the challenges facing us have grown more significantly. Aircraft noise affects five million people in the United States. It is the single greatest barrier to adding new runways and expanding airport operations, and through the constraints it places on the growth of our Air Transportation System, it produces significant negative impacts on our national economy.

Further, we spend hundreds of millions of dollars on a band-aid approach of soundproofing homes around airports rather than investing in the technology which is the only long-term solution.

In terms of air quality, aircraft are responsible for less than one percent of health impacts associated with poor air quality in the United States as a whole, yet these impacts are still very important, one to 200 perhaps more premature deaths each year.

In regards to climate change, most estimates suggest that per unit of fuel burned the impact of aircraft on climate is more significant than that impact from land-based sources. Climate is also an area where there is a vigorous international debate. For example, around EU plans to include international aviation in an emissions trading program.

Unfortunately, this is also an area where the United States most significantly lags our European colleagues. Our entire portfolio of research is likely less than $1 million per year. This for the most uncertain and potentially most damaging environmental impact of aviation.

In terms of jointly addressing the challenges of noise, air quality, and climate change, and achieving absolute reductions in impacts at the same time the system is growing, history provides a lesson. In the '70s, '80s, and '90s, we had a 95 percent reduction in the

number of people impacted by aircraft noise. At the same time we had a six-fold increase in passenger miles traveled.

And at that very same time we had a 60 percent improvement in energy efficiency, more than any other mode of transport. All of those remarkable improvements came from technology that was derived from strong FAA, NASA, industry, university research programs.

Today further improvements are possible, improvements that can enable us to achieve absolute reductions while we grow. However, achieving these improvements is dependent on making the right decisions, and that requires a healthy scientific research program and also on sufficient sustained investments in the development of new technologies, NextGen operations, and alternative fuels.

So what has changed since we wrote the 2004 report to Congress on aviation and environment? The most important change is that the challenges we are facing have gotten even more significant. In particular, if we were writing the report today, we would likely add contributions to climate change to the list of impacts we would seek to reduce in absolute terms, and there would be much greater focus on energy dependence.

There have also been some successes in the last four years since we wrote the report to Congress. The FAA Office of Environment and Energy headed by Carl Burleson and Chief Scientist Dr. Lourdes Maurice, have led a sea change in the FAA. They have adopted a rigorous science-based approach to understanding aviation's impacts and making policy decisions based on that. Under their leadership with the participation of many others, I believe the environmental working group of JPDO is regarded as one of the best.

Today the two most critical issues that we must address are first to accelerate the FAA/NASA Aviation Climate Change Research Initiative and second, to significantly increase the focus, technology, operations, and alternative fuels programs in NASA and FAA that are required to effectively bridge fundamental aeronautics research and industrial development programs.

This is consistent with the pending FAA and NASA Reauthorization Bills, and I sincerely thank this committee for its efforts in that regard. It is the right thing to do for the health of the planet and for the health of the public. It is the right thing to do for the economy.

The constraints on the system are sufficiently strong that they can impede realizing the potential of NextGen. If we do not achieve significant advances in environmental performance, there will be increasing impacts on health and welfare and increasing constraints on the National Air Transportation System with the negative economic impacts that come with both.

Thank you very much, Mr. Chairman and Members of this committee for the opportunity to address you. I will be pleased to respond to your questions.

[The prepared statement of Dr. Waitz follows:]

PREPARED STATEMENT OF IAN A. WAITZ

Chairman Gordon and Members of the Committee, thank you for the opportunity to comment on the status of the Next Generation Air Transportation System initiative (NextGen) with regards to the impacts of aviation on the environment. I am

the Head of the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology and Director of the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER). For 17 years I have conducted research directed towards understanding and reducing the environmental impacts of aviation. This work has spanned climate change, air quality, noise, and economic effects, and has included technological, operational, and policy dimensions. I work closely with the FAA Office of Environment and Energy.

My written testimony is organized in six sections. Section I briefly describes PARTNER. Section 2 summarizes the key findings from the 2004 Report to Congress on Aviation and the Environment. Section 3 provides an overview of noise, air quality, and climate change issues related to the national air transportation system. Within this section, I make several comments on current FAA and NASA programs and plans. In Section 4 I draw from the discussions of the Section 3 noise, air quality, and climate change overview and summarize what has changed since the 2004 Report to Congress on Aviation and the Environment. In Section 5 I share my views on the progress of the NextGen initiative and the Joint Planning and Development Office (JPDO). Section 6 concludes with the issues that I feel most urgently need to be addressed.

My main message is that the United States must accelerate efforts to address the environmental impacts of aviation. It is the right thing to do for the health of the public and the planet. It is also the right thing to do for the economy. If we do not achieve significant advances in environmental performance there will be increasing impacts on health and welfare, and increasing constraints on the national air transportation system—with the attendant negative economic impacts that come with both. The constraints are sufficiently strong that they can impede realizing the potential of the Next Generation Air Transportation System. I therefore strongly support increases in funding for environmental research, development, and demonstration programs, such as those described in the pending FAA and NASA Reauthorizations. The priority must be on appropriating funds to programs that address aviation's environmental impacts starting with the FY09 budget. Thereafter, authorization and appropriation of funding for more significant programs are required.

1. PARTNER

PARTNER is an FAA/NASA/Transport Canada-funded Center of Excellence, founded in 2003, that focuses on improving the scientific understanding of aviation's environmental impacts, and on assessing, developing, and implementing technological, operational, and policy options for mitigating these environmental impacts. Educating future researchers and leaders in aviation and environment is an overarching goal. We have more than fifty graduate students working with leading faculty members at the Georgia Institute of Technology, Harvard University School of Public Health, Massachusetts Institute of Technology, Pennsylvania State University, Purdue University, Stanford University, Missouri University of Science and Technology, University of North Carolina, York University in Canada, and University of Reading and University of Cambridge in the United Kingdom.

One of PARTNER's greatest strengths is our advisory board. More than 50 U.S. and international organizations are represented including aerospace manufacturers, airlines, airports, national, State and local government, professional and trade associations, non-governmental organizations and community groups.

Hundreds of PARTNER investigators, students, and advisory board members have worked collaboratively over the last five years under the sponsorship of the FAA, NASA, Transport Canada, DOD, and the Airports Cooperative Research Council (ACRD) to advance understanding of the relationship between aviation and environment. This work has included:

- designing and testing alternate descent patterns as a no/low-cost means to reduce aircraft landing noise, fuel consumption, and pollutant emissions
- three significant measurement campaigns at U.S. airports to assess and understand the formation of particulate matter from aircraft
- collaborating with NASA and industry studying noise acceptability of supersonic flight over land
- examining land use, noise, and local development dynamics related to airport encroachment
- assessment of the human health and welfare risks of aviation noise, local air quality, and climate change impacts
- analyses of the costs and benefits of alternative fuels for aviation

- development of aircraft and air transportation system simulations to assess policies, technologies and operational options for enabling environmentally responsible air transportation growth
- online resource development to better inform the public about aircraft noise issues.

2. 2004 Report to Congress on Aviation and the Environment

One of the first collaborative endeavors undertaken by PARTNER was to draft a report to the United States Congress on behalf of the Secretary of Transportation and the Administrator of NASA. The report, which is titled *Aviation and the Environment: A National Vision Statement, Framework for Goals, and Recommended Actions,* represents the collective views of a broad range of stakeholders. Thirty-eight organizations participated, spanning the aerospace industry, NASA, FAA, the Environmental Protection Agency, Department of Commerce, Department of Defense, academia, State and local governments, and community activists. It was my privilege to be the lead author of the report (*http://mit.edu/aeroastro/partner/reports/congrept_aviation_envirn.pdf*).

The report's most important element is a proposal for a National Vision Statement for Aviation and the Environment. This vision statement was supported by every one of the 59 stakeholders who participated in drafting it. The National Vision specifies *absolute reductions* in significant health and welfare impacts from aviation noise and air quality emissions—notwithstanding growth, reduced uncertainty in understanding other impacts, and global leadership for the U.S. aerospace enterprise in addressing aviation mobility and environmental needs.

Figure 1: The image depicts the relationship between the recommended actions and the National Vision for Aviation and the Environment. Technology, Operations and Policy represent a balanced approach to addressing aviation mobility and environmental needs. These are placed in an inverted triangle to signify that the balance is dependent on the supporting elements of Communication and Coordination, and Tools and Metrics. It is only with all three of these elements in place that the National Vision of absolute reductions, reduced uncertainty, and global leadership will be achieved.

To achieve this challenging vision, the 2004 Report to Congress on Aviation and the Environment recommends three actions. The first is to promote coordination and communication among stakeholders. This should be interpreted as a call for a structure like the Joint Planning and Development Office. The second is to develop more effective tools and metrics for guiding policy decisions and for planning research investments. This is the area where some of the most important advances are occurring within FAA, but also where further work is required in the area of climate change. The third recommended action is to establish a vigorous program to develop specific technological, operational and policy options that support a balanced approach to long-term environmental improvements. My concerns are greatest with regard to progress on this third action.

This vision and the recommended actions have been adopted as the basis for the environmental objectives and plans of the NextGen Initiative,[1] the FAA's National

[1] *http://www.jpdo.gov/iwp.asp*

Aviation Research Plan,[2] and the National Science and Technology Council's National Plan for Aeronautics Research and Development.[3]

I will return to the findings of this report later in my testimony. In particular, as you have requested, I will comment on what has changed since the report's publication (Section 4), share my views on the progress of the NextGen initiative and the JPDO (Section 5), and identify the issues I believe most urgently need to be addressed (Section 6).

3. Aviation, Environment and Mobility

Before commenting specifically on the NextGen initiative, it is useful to describe what we know and do not know about the environmental impacts of the U.S. air transportation system, and to set these impacts in the context of environmental impacts from other sources. I start by sharing two quotes:

> **"Flying—the worst thing,to do . . . The dirtiest industry in the world."**
> B. Sewill, *Fly Now, Grieve Later,* 2005

> **". . . unrelenting carbon-efficient improvement is business as usual for commercial airlines . . . We are the greenest form of mass transportation."**
> J.C. May, ATA President and CEO, Congressional Testimony, 2007

What are we to make of these differences of opinion? In Europe for example, sentiments in the press, and those held by many in the public, are quite negative. It is "common knowledge" for some that aviation is a dirty business. This common knowledge is not consistent with scientific assessments. There are certainly important impacts on human health, welfare, and ecological systems from aviation that must be addressed (I detail many of these below). However, it is equally true that the air transportation industry has made, and can continue to make, significant improvements. For example, in the last 30 years, there was a 60 percent reduction in energy intensity in air transportation, a reduction that is larger than that of any other mode of transportation. Indeed, between 2000 and 2007, fuel use and CO_2 emissions from U.S. commercial aviation have decreased by three percent in absolute terms despite 12 percent more passenger movements and 22 percent more freight flown.[4]

More importantly, further improvements are possible with new technologies and new fuels—improvements that will enable aviation to remain a small, and possibly even decreasing, contributor to the overall environmental burden of human activities. However, achieving these improvements is dependent on making the right decisions (which requires healthy scientific research programs), and on sufficient, sustained investments in the development of new technologies, operational procedures and alternative fuels. Thus, while it is possible for aviation's impacts on the environment to be reduced in absolute terms, it is more probable at our current levels of investment that aviation environmental impacts will grow—contributing to greater detriments on health and welfare, and further constraints on our air transportation system and the economic growth it enables.

I started with the two quotes, "Flying—the worst thing to do," and ". . . the greenest form of mass transportation," to focus your attention to the value of knowledge, knowledge that can be used to make rational judgments about what matters, why it matters, and to whom it matters. Aircraft, and the air transportation systems in which they operate are highly optimized complex systems. As such, there are important tradeoffs and interdependencies. For example, if one designs an airplane to minimize noise, impacts on climate and air quality can worsen and vice versa. Further, there are almost always important safety and economic implications that come with design changes. How should one decide what is more or less important?

The issues highlighted by the quotes I shared go well beyond posturing in the press. The public and political views in Europe and the United States, and the policies to which they may lead, will affect us all—for better or for worse. Aviation is a global business, with airplanes designed by a small number of suppliers, largely for a single global market. If policies are imposed in one part of the world that push aircraft design in a certain direction, all of us will fly on those airplanes. Therefore,

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[2] *http://www.faa.gov/about/office_org/headquarters_offices/ato/publications/oep/plans/images/2007NARP.pdf*

[3] *http://www.ostp.gov/galleries/default-file/Final%20National%20Aero%20RD%20Plan%20HIGH%20RES.pdf*

[4] During the same period, CO_2 emissions from aviation in Europe rose approximately 30 percent.

there is a premium on getting the answer right when assessing tradeoffs and interdependencies. This is especially true because new airplane development times are as long as a decade, and airplane usage in the fleet is as long as three decades. In aviation, when we make decisions, they tend to be expensive, and we must live with them for a long time.

It is in this area, the area of developing the knowledge and tools to make rational decisions about environmental impacts, where the FAA, in particular its Office of Environment and Energy, has been leading the world. The FAA has adopted a rigorous, rational, science-based approach to understanding what matters, why it matters, and to whom it matters. This is the most critical first step to taking action, especially for a system as complex as our national air transportation system. A detailed plan for research aimed at further developing this understanding is contained within the latest draft of the NextGen Integrated Work Plan.[5] I was one of many people who participated in developing the plan, and I strongly support it.

In the next three subsections, I describe in turn issues related to aviation noise, air quality impacts, and climate change. Many of the estimates of impacts I describe come from research programs funded in the last five years by the FAA Office of Environment and Energy. Many of the significant technological advances that I describe were enabled and promoted by NASA Aeronautics research and development programs of the 1970s–1990s.

3.1 Noise

There are approximately one-half million people in the United States who live in regions near airports with high levels of aircraft noise, noise levels such that more than 12 percent of the impacted population will be highly annoyed.[6] People are awakened at night, housing values are depreciated, learning in schools is reduced. An estimated five million people live in areas with moderate airplane noise, but still, where greater than three percent of the population will be highly annoyed.[7] Adding these groups together (those in significant and moderate noise areas), there are perhaps 200,000 people in the United States who are highly annoyed by commercial aircraft noise. Despite the magnitude of the number, it is small compared to the number of people living in homes in city centers, and along all of the highways and railways in the United States, where residents suffer similarly from high noise levels.

Further, we have seen dramatic 95 percent *reductions* in the number of people impacted by aircraft noise over the last 35 years (while the population impacted by highway and railway noise is estimated to have increased), and this is despite a sixfold growth in aviation passenger-miles traveled. However, most projections suggest that advances in aircraft technology will barely be able to keep up with growth in order to keep aircraft noise impacts in the United States constant. Meanwhile, we spend hundreds of millions of dollars each year on soundproofing homes (which is little more than a band-aid), local authorities continue to make poor land-use decisions (allowing residential development in high noise regions), and we burn extra fuel for some noise abatement procedures at airports (and suffer the associated economic, climate, and air quality detriments). Most importantly, the very valid complaints of residents around airports have almost halted the airport expansion that could be so vital to our economy. The limits on airport expansion lead to further congestion of our airspace, more flight delays, economic losses, and even more environmental impacts. The Chinese are in the process of building some 50 airports, and expanding another 70. In contrast, consider Boston where I live: efforts to add a third runway to Logan Airport started in the 1970s. The runway was only half-completed when community opposition led to a court injunction halting construction. The injunction was not lifted until 2003—30 years of less efficient, less productive operations that to a large extent were due to concerns about aviation noise.

With this as context, it is useful to understand what led to the dramatic reductions in aviation noise impact that occurred in the 1980s and 1990s. These were a direct result of technological advancements (especially the introduction of the high bypass ratio turbofan engine) and policy incentives (accelerated phase-out of older, noisier aircraft—a phase-out that is estimated to have cost the industry between $5 billion and $10 billion). These technological advancements were founded on robust NASA–FAA–industry–university research and development activities.

In the last several years, funding for the NASA Aeronautics Program has been insufficient to support such robust research and development activities. As a result,

[5] Working draft version dated August 12, 2008.
[6] 65dB and higher Day-Night Noise levels.
[7] 55dB and higher Day-Night Noise levels.

NASA Aeronautics has shifted its focus relatively more towards long-term, fundamental research, with relatively less emphasis on the more costly, system-level technology acceleration and implementation programs. This is an appropriate strategy given the limited funding—fundamental research is the foundation upon which all the other efforts are built. However, it is not a strategy that is promoting the development and implementation of low noise technology to the degree that is required. While the modest augmentations in recent NASA Aeronautics budgets have been welcome, they have varied from year to year, making it difficult to launch the multi-year programs that are necessary for success. I note that the NASA programs are strongly driven by the NextGen goals, and are explicitly incorporated in the NextGen Integrated Work Plan. The team is well coordinated. The missing element is an increased and sustained funding commitment. The FAA FY09 budget request also includes funds to more rapidly develop and implement low noise technology and procedures (as one component of the Continuous Lower Energy, Emissions, and Noise Program, CLEEN). This program, with a proposed budget of $22M per year (for all objectives, not just noise reduction) can be an important contributor to an effective, vertically-integrated national research and development program. But here too, funds must be appropriated.

Thus, while we underfund the research and development that is the only pathway to long-term improvement, we continue to spend hundreds of millions of dollars each year on the band-aid approach of soundproofing homes and purchasing land around airports. Because we have under-invested in research and development, this band-aid is indeed, the only option for residents near airports, residents who justifiably have had enough with bearing the burden of the high noise environments. The national strategy for addressing aircraft noise is broken. New technology can change the equation and significantly reduce the requirements for soundproofing and the hundreds of millions of dollars it drains from the Airport and Airway Trust Fund through the Airport Improvement Program.[8] We must challenge the Nation's government-industry-university research enterprise to do this and we must appropriately fund it. This will break the logjam between aircraft noise and airport expansion, promote economic growth, reduce health and welfare impacts on residents living near airports, and contribute to scientific and technological advancement.

3.2 Air Quality

Commercial aviation is responsible for between two percent and three percent of U.S. energy consumption, almost all of it from petroleum. The competitiveness of the industry and the high fraction of costs related to fuel, have led to a level of penny-pinching for energy efficiency that is unparalleled. Airlines make decisions about seemingly minute items to optimize their financial performance (such as evaluating whether or not to limit the availability of ice cubes as part of the drink service to improve fuel efficiency). The incentives for fuel efficiency are extreme. However, as with other users of fossil fuels, the combustion of these fuels leads to gaseous and particulate matter emissions that can adversely affect human health. Only those emissions emitted below 3,000 feet above ground level are traditionally considered in EPA national inventories and in air quality evaluations, although emerging work suggests that emissions at higher altitudes may also be important for surface air quality. The aviation emissions below 3,000 feet represent between 0.03 percent and 0.4 percent of the total National Emissions Inventory levels depending on the particular pollutant.[9] However, in many U.S. counties the contribution to county-level inventories can be as high as several percent (rising to as high as 20 percent to 50 percent for some pollutants in four counties only). Moreover, there are 148 airports located in non-attainment areas that do not meet National Ambient Air Quality Standards for one or more pollutants. So small contributions can still be quite important.

To my knowledge, the FAA is the only organization in the world that is specifically funding research to understand the health impacts that are attributable to these aviation emissions. It should be commended for this. It is another example of the FAA's rational, rigorous approach to understanding what matters and why it matters. It is important to do so, because even within the different pollutant emissions, there are important trade-offs. For example, high temperature engines that

[8] *For Greener Skies, Reducing the Environmental Impacts of Aviation,* NRC, 2003.

[9] For a one year period in 2005–2006, operations at 325 U.S. airports, including approximately 95 percent of operations for which flight plans were filed, represent the following percentages of the total 2001 U.S. National Emissions inventory for anthropogenic sources: 0.17 percent of carbon monoxide (CO) emissions, 0.40 percent of oxides of nitrogen (NO_X) emissions, 0.23 percent of emissions of volatile organic compounds (VOCs), 0.06 percent of oxides of sulfur (SO_X) emissions, and 0.03 percent of fine particulate matter ($PM_{2.5}$) emissions.

reduce carbon dioxide (CO_2) emissions can increase emissions of oxides of nitrogen (NO_X). A second example is related to emissions of hazardous air pollutants. At the time when we wrote the 2004 Report to Congress, we listed these as one of the highest areas of uncertainty for aviation. Four years later, research funded by the FAA and the Airports Cooperative Research Council is showing that hazardous air pollutants from aviation are not a source of significant health impacts.

Of aviation emissions, those that contribute to ambient fine particulate matter ($PM_{2.5}$) are the most significant source of adverse heath consequences. More than 95 percent of total health impacts attributable to aviation are estimated to come from exposure to increased levels of ambient particulate matter. The emissions that contribute include sulfur oxides, nitrogen oxides, volatile organic emissions (these three groups of emissions are mostly emitted as gases, but later in the atmosphere they lead to secondary formation of particulate matter), and also primary particulate matter emissions (soot). In recent studies, the average contribution of aircraft to ambient levels of $PM_{2.5}$ in the United States was estimated to be less than one-tenth of one percent: 0.08 percent for all counties and 0.06 percent for counties in air quality non-attainment areas. The aircraft contributions to county-level ambient $PM_{2.5}$ concentrations ranged from 0 percent to 0.5 percent. However, this is likely an underestimate since only emissions below 3,000 feet were considered and the geographical resolution of the models was limited.

Although the impacts are quite small relative to all human impacts on air quality, they are important. Using standard health risk assessment approaches, approximately 160 yearly incidences of premature mortality can be attributed to the aviation emissions below 3,000 feet. These health impacts of aviation very likely constitute less than 0.6 percent of the total adverse health impacts due to poor air quality from all anthropogenic emissions sources in the United States—underscoring the overall significance of the health risk associated with poor air quality in the United States which very likely contributes to more than 25,000 premature mortalities each year.

The benefits that NextGen can provide for improving air quality may be significant. Air traffic management inefficiencies, congestion, and delay result in increased fuel burn and emissions. We have all experienced unacceptably long taxi operations, waiting in long lines to take-off, or for an airport gate to become available—all the while with engines running, burning fuel, generating emissions, and wasting time and money.[10] Approximately 10 percent of the fuel burn and emissions below 3,000 feet in today's system are a direct result of delays and inefficient operations. It will only get worse. The air transportation system is a traffic jam waiting to happen. Without the development of an efficient next generation system, small numbers of additional operations (much smaller than the 2x to 3x growth that is anticipated) will increasingly cause gridlock, especially in conditions with poor weather. There is thus, a potential for significant adverse environmental and economic consequences. This is an area where NextGen planning and initiatives are appropriately targeted. Moreover, the modelling and planning tools used by the NextGen program now explicitly incorporate the latest results from air quality health impacts analyses. Although many important scientific questions remain, and it is likely that the estimates of health impacts will change, the research programs have been initiated, and the linkages are in place so that these effects can be appropriately considered in NextGen planning and development.

In addition to NextGen operational improvements, there are also options to reduce air quality impacts through the adoption of low sulfur fuels and alternative fuels. Recognition of the potential role of alternative fuels is one of the key changes since the writing of the 2004 Report to Congress on Aviation and the Environment. The FAA is moving aggressively to pursue the assessment (including the full life cycle impacts), testing, and certification of low sulfur and low carbon alternative fuels. It is not yet clear what the costs and benefits of these options will be, but FAA has put in place a thoughtful, effective research program to develop and assess these options. The work is a component of a larger work program within the Commercial Aviation Alternative Fuels Initiative (CAAFI), a broad government-industry-academic consortium.

While the work on operational improvements and new fuels is proceeding well, programs to develop aircraft and engine technologies for mitigating air quality impacts are not well supported. As with the development of low noise technologies, the reduced levels of funding for NASA Aeronautics in the last decade have left the Nation without sufficiently strong focused technology programs that are important for

[10] The Joint Economic Committee estimated that flight delays in 2007 cost the U.S., economy $41 billion. *Your Flight Has Been Delayed Again: Flight Delays Cost Passengers, Airlines, and the U.S. Economy Billions in 2007.* JEC, 2008.

bridging fundamental research and industrial development, and thereby promoting more rapid advancement of aircraft and engine technology. Here too, the recent augmentations to the NASA Aeronautics budget have been helpful, but they are not enough—and they are not sustained, therefore making them less effective for contributing to long-term development programs. The FAA can also play an important role in addressing the gap with its Continuous Lower Energy, Emissions, and Noise Program, CLEEN. However, as I noted previously, this program, with a FY09 budget request of $22M per year for all objectives, is not sufficient to promote the technological advances that will be required to reduce air quality impacts simultaneously with the anticipated growth of operations.

3.3 Climate Change

Aircraft emissions contribute to climate change by increasing the levels of greenhouse gases in the atmosphere. Commercial aviation is responsible for approximately 2.7 percent of U.S. greenhouse gas emissions (roughly 10 percent of the greenhouse gas emissions from the transportation sector). Because of the altitude at which aircraft fly, the effects on climate are unique among all greenhouse gas emitters. There are effects related to the formation of condensation trails (contrails) and clouds, and positive and negative impacts of NO_X emissions that can be more pronounced than those from surface-level NO_X emissions. These effects cannot simply be added to the effects of the CO_2 emissions; they depend on time of day, time of year, altitude of the emissions, and region of the globe. Although the impacts of aviation CO_2 are well understood, and are the same as those from CO_2 emitted from other sources, many of the other effects are poorly understood. All of them involve complex chemical and atmospheric processes. However, when these effects are taken together, most estimates suggest that the impact of aviation on climate is greater per unit of fuel burn than that from surface-based combustion sources.

As we wrote in the 2004 Report to Congress, this is the area of greatest scientific uncertainty for aviation, and the area with the greatest potential for environmental impacts. It is also an area where there is a vigorous international debate on measures that should be taken to mitigate the impacts—for example, the debate surrounding the European Union plans to include commercial aviation in an emissions trading program. There are also examples closer to home like the petition California and other states filed with the EPA to regulate greenhouse gas emissions from aviation.

Perhaps nowhere in the area of aviation and the environment is there a greater premium on pursuing a rigorous program of scientific study that is closely tied to national and international decision-making needs. This is also the area where the United States most significantly lags our European colleagues. The United States had a robust, vibrant research program (the Atmospheric Effects of Aviation Program). This program was discontinued around the year 2000. Since that time, most of our understanding of the impacts of aviation on climate has come from the excellent programs in Europe. Much of the U.S. academic community has disbanded and gone on to focus on other things. Although work continues, it is not well funded or well connected. Today in the United States, the entire portfolio of funded research focusing on aviation and climate is likely less than $1 million per year—for the most uncertain, and potentially most damaging, environmental impact of aviation. We are now in a position of being insufficiently prepared to contribute to national and international discussions of climate policy for aviation—the latter of which are likely to move ahead with or without us. This is a failure.

To address this critical need, this year the FAA and NASA launched the Aviation Climate Change Research Initiative. With optimistically[11] only $2 million to $3 million of funding per year, this effort must be expanded. Without this, we will be unable to evaluate the complex trade-offs among aviation's climate effects—let alone balance them against other objectives for noise, air quality, safety, and economic performance of the industry. This is a case where engine, aircraft, and operational design trades are quite possible, and industry is asking, "what really matters?" but we do not have an answer for them. All the while, airplanes continue to be built, airplanes with a 30-year lifetime in the fleet. We must change the path we are on, and to do so, we must move more forcefully than we are moving today.

4. What has changed since the 2004 Report to Congress on Aviation and Environment?

I have addressed several points regarding changes since the 2004 Report to Congress in Section 3; I will now summarize them. The report recommended three ac-

[11] It is waiting funding in the FY09 Budget.

tions to achieve a National Vision of absolute reductions in significant health and welfare impacts from aviation noise and air quality emissions, reduced uncertainty in understanding other impacts, and global leadership for the U.S. aerospace enterprise in jointly addressing aviation mobility and environmental needs. In the last four years there have been some successes in responding to this vision, and some failures.

Changes relative to recommendation 1: Promoting coordination and communication among stakeholders.

- The National Vision for Aviation and the Environment and Recommended Actions drafted by a broad group of stakeholders was accepted and acted upon by FAA and NASA, and incorporated into the National Plan for Aeronautics Research and Development and Related Infrastructure (January 10, 2008).[12]
- The Environmental Working Group of the JPDO is regarded as one of the most effective groups within the JPDO. This is evidenced in the 2005 National Research Council Report, *Technology Pathways: Assessing the Integrated Plan for a Next Generation Air Transportation System,* where the activities of the group were highlighted and put forward as an exemplar for other components of the JPDO to follow.
- NASA Aeronautics programs and plans are closely aligned with the needs of the NextGen initiative.
- FAA and NASA have cultivated several open, collaborative research enterprises focused on environment and energy including the Partnership for AiR Transportation Noise and Emissions Reduction, the Aviation Climate Change Research Initiative, the Commercial Aviation Alternative Fuels Initiative, the Aviation Emissions Characterization Roadmap, the NASA Fundamental Aeronautics N+1, N+2 and N+3 research programs, and the Research Consortium for Continuous Lower Energy, Emissions, and Noise (CLEEN).

Changes relative to recommendation 2: Developing more effective tools and metrics for guiding policy decisions and for planning research investments.

- The FAA has led the world in supporting research to understand the air quality impacts of aviation resulting in several seminal contributions.
- The FAA and NASA have led the world in developing tools to characterize and quantify the interdependencies among aviation-related noise and emissions, impacts on health and welfare, and industry and consumer costs, under different policy, technology, operational, and market scenarios.
- One of the most significant changes since the 2004 Report to Congress is the greater recognition of the importance of energy efficiency, and the potential value of alternative fuels for reducing the climate change impacts of aviation and reducing our dependence on non-replenishable resources. The FAA and the DOD have excellent programs in place to rigorously evaluate the full life cycle costs and benefits of alternative fuels for aviation.
- Despite laudable efforts this year to launch the Aviation Climate Change Research Initiative on the part of FAA and NASA, the gap in technical credibility with regard to aviation climate impacts has widened between the United States and Europe in the last four years. Most of the significant research findings are coming from Europe.

Changes relative to recommendation 3: Establishing a vigorous program to develop specific technological, operational, and policy options that support a balanced approach to long-term environmental improvements.

- The FAA is well positioned to develop specific operational and policy options (with the notable exception of the aviation climate area) to support long-term environmental improvements. One highlight is its vigorous development and implementation of Continuous Descent Arrival procedures that reduce noise, reduce emissions, and save fuel.
- Since the writing of the 2004 Report, four more years have passed without sufficient funding for the critical NASA–FAA–industry–university technology development programs that will be required to address the environmental impacts of aviation while enabling growth in air service.

[12] The National Plan was developed in response to Executive Order 13419 which implemented the National Aeronautics R&D Policy. The National Plan establishes high priority national aeronautics research and development challenges, goals and supporting objectives to guide the conduct of U.S. aeronautics R&D activities through 2020.

- Moreover, even the more modest programs proposed in current FAA plans (such as the Continuous Lower Energy, Emissions, and Noise Program, the Aviation Climate Change Research Initiative, expansion of the environmental work in the Airports Cooperative Research Program, and funding for environmental demonstration programs at airports) will not move forward unless funds are appropriated to support them.

5. What steps should the NextGen initiative be taking to mitigate impacts? How satisfied are you with the JPDO's efforts to date?

I have reviewed a working draft of the environmental section of the latest Integrated Work Plan for NextGen (draft dated Aug. 12th 2008). The plans in the environmental section are impressive—rigorous, science-based, detailed, and well coordinated. The extent to which these will be effectively integrated with the overall JPDO work program is still to be determined, but I commend the Environmental Working Group of the JPDO for its efforts. It has truly aspired to put in place a program that will enable an *absolute reduction* in aviation's environmental impacts *notwithstanding growth* of the aviation system. Quoting from the draft Integrated Work Plan:

> *"Therefore, the NextGen challenge is to reduce aviation's environmental footprint, even with projected aviation growth. This includes reducing the impacts of aviation noise, and air quality and greenhouse gas emissions in a cost-beneficial manner."*

The draft Work Plan further describes their path to achieving this:

> *"NextGen must achieve a balance between aviation's environmental impacts and other societal objectives, both domestically and internationally. NextGen can meet these challenges by eliminating system-induced congestion and delay, accelerating the aircraft technology development/penetration cycle and by advancing alternative fuels to manage aviation's environmental impacts."*

This is a useful framework for summarizing my thoughts on NextGen and JPDO. First, as I have highlighted several times, the rational, rigorous, science-based approach adopted by the FAA to evaluate the costs and benefits of various options is exceptional. Second, the efforts to eliminate system-induced congestion and delay are sorely needed. Even today we see significant environmental impacts from these factors. These impacts will occur to an even greater extent if the number of operations is increased without improving the system. The efforts to carefully assess the full life cycle costs of alternative fuels are also very appropriate.

However, it is the area of accelerating the aircraft technology development/penetration cycle that most concerns me. The plans and programs developed by FAA and NASA are excellent. They are well coordinated. The national capabilities in government, industry and academia are excellent. However, the current funding levels in this area are insufficient to support the national vision for absolute reductions in impacts notwithstanding the projected growth.

6. The most critical issues

The two most urgent needs are:

1) To accelerate the FAA–NASA Aviation Climate Change Research Initiative. This will enable a careful evaluation of the complex trade-offs among aviation's climate impacts, and a balancing of these impacts against other objectives for noise, air quality, safety, and economic performance of the industry.
2) To significantly increase and accelerate the focused technology, operations, and alternative fuels programs in NASA and FAA that are required to effectively bridge fundamental aeronautics research and industrial development programs. This will have the single greatest leverage on our ability to achieve long-term environmental improvements in the aviation industry. This can start immediately: important programs have been planned and proposed by the FAA and NASA. However, they are on hold waiting FY09 funding. I encourage you to support, and indeed to expand, these programs.

Accelerating efforts to address the environmental impacts of aviation is the right thing to do for the health of the public and the planet. Commercial aviation is estimated to be responsible for two to three percent of U.S. CO_2 emissions, 160 or more yearly premature mortalities associated with poor air quality, and 200,000 people who are highly annoyed by aircraft noise. While these impacts are small relative to the sum of human environmental impacts, they are nonetheless important. Accelerating efforts to address the environmental impacts of aviation is also the right

thing to do for the economy. The constraints on the system are sufficiently strong that they can impede realizing the potential of NextGen. If we do not achieve significant advances in environmental performance there will be increasing impacts on health and welfare, and increasing constraints on the national air transportation system—with the attendant negative economic impacts that come with both.

The priority must be on appropriating funds to programs that address aviation's environmental impacts starting with the FY09 budget. Thereafter, authorization and appropriation of funding for more significant programs are required.

Thank you very much, Mr. Chairman and Members of this committee for this opportunity to address you. I will be pleased to respond to your questions.

BIOGRAPHY FOR IAN A. WAITZ

Born January 25, 1964, Ann Arbor, Michigan; U.S. Citizen

Education:

Ph.D., 1991, Aeronautics, California Institute of Technology

M.S., 1988, Aeronautics, George Washington University

B.S., 1986, Aerospace Engineering, Pennsylvania State University

History of MIT Appointments:

Charles Stark Draper Assistant Professor, July 1991–October 1991

Rockwell International Assistant Professor, November 1991–November 1994

Assistant Professor, December 1994–June 1997

Associate Professor w/o tenure, July 1997–June 1998

Associate Professor with tenure, July 1998–June 2001

Full Professor, July 2001–present

Associate Head, Aero and Astro, August 2002–December 2003

Deputy Head, Aero and Astro, January 2003–June 2005

Department Head, Aero and Astro, February 2008–present

Overview:

Ian A. Waitz is the Jerome C. Hunsaker Professor and Head of the Department of Aeronautics and Astronautics at MIT. He is also the Director of the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER), an FAA/NASA/Transport Canada-sponsored Center of Excellence. His principal areas of interest are the modeling and evaluation of climate,local air quality and noise impacts of aviation, including the assessment of technological,operational and policy options for mitigating these impacts. He has written approximately 70 technical publications including a report to the U.S. Congress on aviation and the environment,holds three patents and has consulted for many organizations. During 2002–2005 he served as Deputy Head of the Department of Aeronautics and Astronautics. He has also served as an associate editor of the AIAA *Journal of Propulsion and Power*. In 2003 Professor Waitz received a NASA Turning Goals Into Reality Award for Noise Reduction. He was awarded the FAA 2007 Excellence in Aviation Research Award. He is a Fellow of the AIAA, and an ASME and ASEE member. He teaches graduate and undergraduate courses in the fields of thermodynamics and energy conversion, propulsion, and experimental projects. He was honored with the 2002 MIT Class of 1960 Innovation in Education Award and appointment as an MIT MacVicar Faculty Fellow in 2003.

Teaching Experience:

Environmental Aerospace Engineering. Developed to address the growing impact of environmental concerns on aerospace systems. Concentration on aircraft emissions and noise is set within a broad contextual backdrop, including discussions of ethics, regulatory measures, environmental assessment, global change, economics, urban planning, and policy.

Aircraft Propulsion and Gas Turbines. Graduate level course devoted to performance and characteristics of aircraft engines and industrial gas turbines as determined by the thermodynamic and fluid mechanic behavior of components: inlets, compressors, combustors, turbines and nozzles.

Internal Flows in Turbomachines. Advanced graduate level course covering concepts of rotational flows, inherent unsteadiness of turbomachines, boundary layers, and wakes and losses in turbomachines.

Thermal Engineering. Junior level undergraduate course in thermodynamics and heat transfer.

Experimental Projects I and II. Selection and detailed planning of an individual research project during the first semester, is followed by construction and experimentation during the second semester. Formal written and oral presentations are made by each of the students.

Unified Engineering. Sophomore level undergraduate course presents the fundamentals of solid mechanics, fluid mechanics, dynamics, thermodynamics and propulsion, and forms the foundation for all other courses taught by the department. The course is the equivalent of four semester-long courses, and is cooperatively taught over the period of a year by several faculty.

Research Interests:

Aviation Environmental Portfolio Management Tool: Working with an international team of researchers under FAA sponsorship to develop an aviation system environmental-economic model to better inform national and international policymaking. The model will enable better assessment of the interdependencies between aviation-related noise and emissions effects, and will provide comprehensive cost analyses of aviation environmental impacts under different technology, operations, policy, market and environmental scenarios. Participants include Georgia Institute of Technology Aerospace Systems Design Laboratory, Harvard School of Public Health, BB&C, ICF, MVA, Vital Link Policy Analysis, MITRE, Volpe National Transportation Systems Center, and Wyle Laboratories. (Active)

Environmental Design Space: Working with researchers from the Georgia Institute of Technology Aerospace Systems Design Laboratory under FAA sponsorship to develop aircraft system-level tools for assessing tradeoffs and interdependencies among technological and operational strategies for minimizing noise, local air quality and climate change impacts of aircraft. (Active)

Alternative Fuels for Aviation: Sponsored by FAA and DOD to explore the potential to reduce aviation environmental impacts via alternative fuels while taking into account the full life cycle of these fuels. (Active)

Impacts of Aircraft Emissions on Air Quality and Public Health: Working with researchers at Cambridge University, University of North Carolina, Boise State University, Harvard School of Public Health, Stanford University, and the University of Houston under FAA and other sponsorship to perform air quality simulations and health impacts assessments of aviation emissions. The work includes a study with FAA and EPA of U.S. air quality impacts in response to the *Energy Policy Act of 2005,* assessments of the impacts of low sulfur and alternative fuels, analyses of the global effects of cruise level emissions, and development of reduced order models for use in policy analyses. (Active)

Chemical and Microphysical Processes in the Turbine, Exhaust Nozzle, and Plume: To aid in assessing the atmospheric effects of current and future aircraft, working with Aerodyne Research Incorporated under FAA, NASA and DOD sponsorship to conduct numerical investigations of the chemistry and microphysics of primary pollutant species, short-lived radicals, and particulate matter, downstream of the combustor, in the turbine, exhaust nozzle, and plume. (Active)

The Value of Environmental Technology in Commercial Aviation: Developing probabilistic valuations for comparing aviation climate, noise, and air quality impacts based on uncertain health and welfare impacts and technological and operational performance. (Active)

System for Assessing Global Aviation Emissions: Worked with researchers from the MIT International Center for Air Transportation and the Volpe National Transportation Systems Center through funding from the FAA to develop an internationally-accepted model for assessing emissions from aircraft (SAGE). (Inactive)

Operational Strategies for Contrail Mitigation: Used an aviation system model to assess the costs and benefits of aircraft trajectory and routing changes as a means to reduce contrail and aviation-induced cirrus cloudiness. (Inactive)

The Economic Value of Silence: Worked with researchers from Cambridge University on the Silent Aircraft Initiative to assess the impact of low noise technology and operational procedures on airline financial performance and regional economic performance. (Inactive)

Robust Aerothermodynamic Design of Gas Turbine Engines. Worked with a group of researchers within the Gas Turbine Laboratory to develop methods for designing gas turbine cycles and components to minimize performance variability in response to operating and manufacturing variability. (Inactive)

Micro-Engines: Conducted experimental and numerical research in micro-scale combustion systems to support the development of a 1mm^2 inlet area micro-gas turbine generator using silicon microfabrication technology. (Inactive)

High Fuel-Air Ratio Combustor and Turbine Research: Conducted numerical and experimental work to understand unique reacting flow physics and heat transfer effects within very high temperature gas turbine cycles. (Inactive)

Reduction of turbomachinery fan noise: Numerical simulations and experiments to investigate the impact of various blade wake management strategies on rotor-stator interaction tone noise. (Inactive)

Ejectors for jet noise reduction: Advanced mixer/ejector devices were studied both computationally and experimentally to provide insight into basic fluid mechanics and acoustics in an effort to develop design procedures for these devices. (Inactive)

Consulting:

9/91–11/92—California Institute of Technology, Pasadena, California; Supersonic combustion, testing and analysis

3/93–1/95—PRC Inc., Mt. Laurel, New Jersey; Internal flow design and analysis

7/94–3/95—Thermo Energy Systems Corporation, Waltham, Massachusetts; Analysis of novel fluid-dynamic power generation scheme

11/94–3/95—Cummins Engine Company, Inc., Columbus, Indiana; Analysis of gas-turbine technology trends for power generation markets

3/95–1/96—Visidyne, Inc., Burlington, Massachusetts; Analysis of flow diagnostic techniques

1/96–10/98—General Electric, Aircraft Engines Group, Lynn, Massachusetts; Gas turbine test facility evaluation

12/95–6/97—Allison Advanced Development Company, Indianapolis, Indiana; Conducted wind-tunnel experiments

8/96–8/96—Volvo Aero, Trollhättan, Sweden; Professional development course

2/96–3/96—Rasor Associates, Inc., Sunnyvale, California; Evaluation of combustion process

12/96–2/97—CFD Research Corporation, Huntsville, Alabama; Micro-combustion processes

8/27–9/27—Russell & DuMoulin, Vancouver B.C., Canada; Aircraft noise

3/95–5/98—Telectro-Mek, Inc., Fort Wayne, Indiana; Development of thrust measuring systems for aircraft

2/96–present—United Technologies Corporation, East Hartford, Connecticut; Gas turbine combustion, noise and professional development courses

9/97–10/97—Deka Research and Development Corp., Manchester, New Hampshire; Combustor design

10/97–2/00—Skadden, Arps, Slate, Meagher & Flom LLP, Los Angeles, CA; Gas turbine combustion processes

3/98–9/98—WorkSmart Energy Enterprises, Inc., Chevy Chase, MD; Evaluated the technical feasibility of utilizing company's invention to improve heat engine efficiency

8/98–5/04—U.S. Environmental Protection Agency; Aircraft technology for low emissions

4/99–9/02—Naval Facilities Engineering Service Center; Pollution prevention technology development

10/99–6/02—Institute for Defense Analyses; Defense Science Study Group

4/00–12/00—Universal Technology Corporation; Joint Strike Fighter Independent Technical Review Team (Air Quality & Noise)

6/01–9/01—Tamarac, LLC; Gas turbine durability

11/01–12/03—Meggitt Avionics, Inc.; Engine diagnostics

5/02–12/02—U.S. General Accounting Office; Aircraft emissions

8/02–12/02—Raytheon Missile Systems

8/02–present—Rolls-Royce, plc; Chair, Environmental Advisory Board

9/02–1/04—Alstom Power, Inc.; Gas turbine design and performance

9/07–present—Wyle Laboratories; Consultant for ACRP 02–06, Greenhouse Gas Emissions Inventories for Airports

Professional Activities:

Associate Editor, AIAA *Journal of Propulsion and Power,* 1996–99

AIAA Fellow (2005), Chair of Turbine Engine Committee 1996–98; AIAA Air-Breathing Propulsion Technical Committee 1995–1999

Member, ASME Turbomachinery Committee

Member, American Society of Engineering Education

Lead Author, United Nations Environment Programme, Intergovernmental Panel on Climate Change, Special Report on Aviation and the Global Atmosphere, 1999

Defense Sciences Study Group, Class of 2000–2001

Joint Strike Fighter Independent Technical Review Team for Air Quality and Noise, 2000

NRC Committee on Aeronautics Research and Technology for Environmental Compatibility, 2000–2001

NASA Aircraft Engine Emissions Characterization and Inventory Committee, 2001–2003

NASA Quiet Aircraft Technology Technical Working Group, 2001–2003

Duke University Mechanical Engineering Undergraduate Advisory Board, 2001–present

Defense Science Board Task Force on B–52 Re-Engining, 2002

Member of U.S. Delegation to ICAO Committee on Aviation and Environment/6 (as an advisor), 2004

FAA National Particulate Roadmap, Impacts Team lead, 2004–present

Director of Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER), an FAA/NASA/Transport Canada-sponsored Center of Excellence, 2004–present

Director, Congressional Study on Long-Term Environmental Improvements for Aviation, 2004–2005

NRC Committee to Assess the Integrated Plan for a Next Generation Air Transportation System (JPDO), 2004–2005

National Academy of Engineering, Steering Committee for Technology for a Quieter America Study, Chair Cost-Benefit Analysis Subcommittee, 2006–present

Transportation Research Board/National Academy of Sciences Study on Transportation and Greenhouse Gas Reduction, Committee member, 2007–present

Honors and Awards:

Raymond L. Bisplinghoff Faculty Fellow, July 2000–June 2003

MIT Class of 1960 Innovation in Education Award, 2002

MIT MacVicar Faculty Fellow, 2003–present

NASA 2003 Turning Goals Into Reality Award For Noise Reduction, 2003

Elected Fellow, AIAA, 2006

FAA 2007 Excellence in Aviation Research Award, 2007

Publications:

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Micro Heat Engines

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A.H. Epstein, S.D. Senturia, I.A. Waitz, J.H. Lang, S. Jacobson, F.F. Ehrich, M.A. Schmidt, G.K. Ananthasuresh, M.S. Spearing, K.S. Breuer, S.F. Nagle
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DISCUSSION

Chairman GORDON. Thank you, Dr. Waitz. I am very sympathetic to your suggestions. This committee has tried to in various capacities authorize that R&D. It is very important to the country. We have got to get the funding to follow up, which means we need Presidential leadership and help in that regard.

So at this point I am going to open up the first round of questions. I will be recognized for five minutes and following up on that topic let me just say that it is clear that all of you agree that it is important that NextGen be successful, and I think it is important that we have a President who is supportive, provides funding and leadership. We are going to have an election soon and a new President here in just a few months, and so we are trying to put together as a Committee some recommendations for the next President, whomever that might be, in areas of our jurisdiction.

RECOMMENDATIONS TO THE NEXT PRESIDENT

So I would like to take a quick couple of minutes here to get your recommendations on what we should then make to the next President concerning NextGen. Why don't we start, well, Dr. Waitz, you want to start with yourself?

Dr. WAITZ. Certainly. I would be pleased to. My primary recommendation would be to recognize that mobility and environment are both public goods, and right now they are standing in the way of one another. And a small amount of investment in the area resolving these problems could have a major payoff. So I think it is an excellent area for us to invest in terms of advancing our scientific understanding, as well as our ability to develop and advance the Air Transportation System.

Chairman GORDON. Anyone else have any recommendations that you would like for us to include? Yes, sir.

Dr. DILLINGHAM. Mr. Chairman, I think you hit the nail on the head when you talked about having the President or the new Administration recognize that this is a very crucial issue for the Nation in terms of the role that transportation plays both in the global economy as well as domestically. And I think it is also important that the identification and confirmation process for the Cabinet level as well as the FAA Administrator be high on the list, because right now we are at a situation where there is, you know, that leadership is very important as champions for NextGen and transportation.

Chairman GORDON. Hopefully that confirmation process will make that clear. Does anyone else like to—yes, sir.

Dr. KAMINSKI. Mr. Chairman, I think the important word here really is execution, for us to begin to get on with the implementation of this program and with the kind of foundation plan that I

have put in the statement for the record I think it is a way to actually achieve this, to get on with the program and to also build the personnel skills that are going to be needed for this kind of key development. And that ought to be highlighted to an incoming President.

Chairman GORDON. Mr. Scovel.

Mr. SCOVEL. Thank you, Mr. Chairman. Let me, there have been general comments. Let me highlight one specific observation for the Committee's consideration.

And that is keeping in mind your jurisdiction over NASA. As the Committee well knows, NASA has reduced its funding for JPDO and NextGen and has chosen to focus more on fundamental research than on its customary role in the past of not only research but also developing prototypes which it could hand up to the FAA when they were appropriately ready.

Our office in conjunction with the NASA IG has undertaken a study of specific areas where NASA has made reductions in funding, has cut back to fundamental research. It may well be wise for this committee, if I may suggest, that you consider recommending to the President that NASA receives sufficient funding to not only conduct its fundamental research but to bring prototypes to FAA so that NextGen can get that added boost.

Chairman GORDON. We have put that in our authorization, unfortunately, we have seen across-the-board reductions in aeronautics research.

Ms. Cox, do you want to finish up on this one?

Ms. COX. Yes. Thank you. The FAA would also welcome the national attention and the focus on NextGen. We have quite a few plans underway, and we are, as you can see from my testimony, we have made some great progress that we would like to see continue.

Our budget request for '09, and beyond represents significant increases over past years, and we think that it is important to continue to support the program in a carefully-aligned and consistent way. And so we would ask for that. Thank you.

Chairman GORDON. Thank you. We are on a timeline, so let me just try to quickly get through one more question.

I have a variety of other questions, particularly for Ms. Cox that I am going to submit for the record and but let me just finish up here.

FAA REORGANIZATION

Dr. Dillingham, as you have pointed out, provisions were included in the House-passed FAA Authorization Bill to strengthen the JPDO by having its director report directly to the FAA Administrator. In addition, I am responding to a request for the record from the Aviation Subcommittee Chairman Costello on the extent to which moving JPDO out of the FAA's air traffic organization and how it would give the JPDO greater visibility and authority. GAO stated, and I quote GAO that, "JPDO's dual reporting status hinders its ability to interact on an equal footing with ATO and the other partner agencies." GAO also said, and I quote, "JPDO must counter the perception that it is a proxy for the ATO and as such is not able to act as an honest broker." And finally, GAO added

that it is important for JPDO to have some independence from ATO, one exchange that, or one change that could, again, to address this issue would be to have the JPDO Director report directly to the FAA Administrator.

And Dr. Dillingham, after the FAA's recent reorganization, the JPDO Director has two ATO management layers above him before he can reach the Administrator. Are you concerned that JPDO lacks sufficient independence from ATO as a result of this restructure? What would be the potential consequences of the lack of independence?

And Mr. Scovel, from your perspective what is the impact of FAA's reorganization on the NextGen development implementation effort? And can you elaborate on how you would characterize in your statement as friction between the JPDO and ATO?

Dr. DILLINGHAM. Thank you, Mr. Chairman. You certainly got our words correct from the last time we talked. I guess our bottom line on this is the jury is still out in terms of how this new governance, new organizational structure is going to play with the external stakeholders. We, as you correctly said, we have said that we believe that a direct report to the Administrator was the best arrangement. It was similar to what was in the House Reauthorization.

And the reason, part of the reason we said that is because if JPDO is going to be seen by the partner agencies as an objective, independent facilitator of multi-agency activities, then it seems to be important that they are on equal footing with some of the other parts of FAA and have a direct report that it doesn't have to go through.

We, when we talked to FAA to about this, one of the concerns, and we have talked to Chairman Costello about the same things and we didn't get the sense that the stakeholders had been allowed to comment on this, that it was more presented to them as a fait accompli. FAA has since told us that the internal stakeholders within FAA are supportive of this new arrangement, and we suggested that they go and talk to the external stakeholders and see if they are feeling the same way.

And, you know, I guess one of the big things and something that you mentioned, Mr. Chairman, is when these major reorganizations take place, it seems that Congressional consultation should be a part of that as well.

Chairman GORDON. Chairman Costello is itching to follow up on this, and he will have his chance here in just a moment.

Let me just, to be brief, and as you said, the jury is out on whether this is going to be successful. I would add to that that the burden of proof is on the FAA to determine that this change of operation is successful when it is against most all the advice.

I would like to go further, but I can't. I now recognize Mr. Hall for five minutes.

Mr. HALL. If Mr. Costello has a problem with staying, I will yield some of my time to you now.

Chairman GORDON. I think his problem is sitting still in his seat.

NEXTGEN FUNDING

Mr. HALL. Okay. Well, my first question will be to Ms. Cox, and you know, this is the time of year we go to hearing about CRs and at the end of every session CRs are pitched around, and I guess if the people, the voters ever really realized and understand what a CR is, that they are going to empty the capital of everybody, Republicans and Democrats up here that yield to the use of CRs. CRs to me is simply saying we are going to do next year what we did last year because we can't get together this year. And it narrows right down to that.

But, Ms. Cox, I wanted to ask you if FAA is funded through a continuing resolution for all of the FY '09, what impact would it have on NextGen and the JPDO? You know what this year and what last year did.

Ms. COX. Correct. Our interest is in maintaining a continuous funding stream for NextGen so that we can continue the plans that we have in place. We are concerned about a CR, a year-long CR is particularly concerning in terms of our ability to carry out our plans that we have laid for NextGen and the requirements.

We are sufficiently aligned to make use of the funding in a prompt manner as it comes on board. A concern is, as I mentioned earlier, we have a rather large increase in our budget request for fiscal year '09, that we need to get this rolling. So the language around the CR will be important to us as we move forward.

Mr. HALL. And I thank you for that.

Dr. Dillingham or Mr. Scovel, how would you assess OMB's record up to this time of coordinating and aligning research budgets among participating federal agencies, and how has OMB been effective, if they have been effective? And a lot of times we question their effectiveness. A lot of times.

Dr. DILLINGHAM. Mr. Hall, I think that in this case the efforts have been noteworthy. Early on because this is a multi-agency enterprise, the idea of working together and ensuring that resources that are aimed for NextGen are, in fact, considered as a portfolio in OMB's consideration I think is a step forward that JPDO and FAA has been able to achieve. It is very hard to, or at least historically it has been very difficult to marshal cross-agency projects, particularly when you are talking about five or six different Cabinet-level organizations.

Mr. HALL. Thank you. And Mr. Scovel.

Mr. SCOVEL. Thank you, Mr. Hall.

Mr. HALL. Your opinion on that.

Mr. SCOVEL. Yes, if I may. Thank you. My statement, sir, speaks to disconnects between FAA and other agencies which might well be remedied through greater OMB attention to FAA's NextGen effort. Specifically, I have mentioned earlier between FAA and NASA and the fundamental research question. Our statement also speaks to the disconnect between FAA and DOD and DHS on surveillance efforts between FAA and DOD on Net Centric Operations efforts and most tellingly I think and the clearest example of all of this is between FAA and the Department of Commerce and specifically NOAA on the weather capabilities question, the so-called 4–D Weather Cube. There is a great difference between the budget re-

quest that Department of Commerce has submitted for NOAA to coordinate weather and what FAA on the other hand expects, and it requires some great attention and resolution at the OMB level.

THE DEVELOPMENT OF ALTERNATIVE JET FUELS

Mr. HALL. I thank you for that. Dr. Waitz, there is a lot of talk today about coal to liquid and a lot of questions and differences on drilling and when we drill and why don't we drill and all that.

You suggest that aviation's impact on the climate might be reduced through the development of alternative jet fuels. I think such as coal to liquid. What other types of fuels are under study, and I guess more importantly than that, including production and distribution, will they produce substantially less carbon than the conventional petroleum-based fuels? And will they have a similar carbon footprint, and any estimates on costs compared to petroleum-based fuels?

Dr. WAITZ. You have identified all of the right issues. The production of fuels from alternative sources is something that we know how to do. Coal to liquid is only a good solution for the environment if we can find a way to sequester the CO_2 as part of that, and that is a huge grand challenge.

Mr. HALL. We have more coal than any—more usable coal I am told than any other nation in the world.

Dr. WAITZ. Understood. That tends to increase the production of CO_2 rather than decrease it on going coal to liquid. I think the most promising things to look to are bio sources, particularly those that do not compete with, you know, food crops and things, because there can be some friction between the two. I expect that there would be very limited amounts of resources for doing that to make significant changes, at least initially, but there is also a very healthy research enterprise that is looking at that topic, and it is one of the, you know, things that we have to pay a lot of attention to because if we could solve that problem and really produce fuels from bio sources that had no net CO_2 impact, it would change the equation. So it is an important thing to pursue.

Mr. HALL. My time is up or I would ask you about the cost estimates, but I will get back to that.

Chairman GORDON. You can submit any questions for the record, Mr. Hall.

And really, the Congressional leader in, concerning FutureGen is, well, FutureGen and NextGen, is Congressman Costello. Chairman Costello, and he is recognized for five minutes.

GENERAL COMMENTS ON NEXTGEN

Mr. COSTELLO. Mr. Chairman, thank you, and I thank you for your kind words in your opening statements, and I thank Mr. Hall for offering to yield to me as well.

You know, we could get into a lot of issues here concerning NextGen, but we have limited time. Let me say that it is an important project. Everyone recognizes that, all of the stakeholders. This is a huge project for the FAA to handle. Frankly, we need to move from a radar-based system to satellite technology that will increase

the safety and efficiency and environmental capacity of our Air Transport System.

But I have to tell you, and I have said this at the T&I Committee, I have said it in briefings, I have said it in round tables, I have said it in meetings with Ms. Cox and many others from the FAA. I really question if the FAA has the capability and the capacity to manage a project of this magnitude. And I say that for the record with Members of the Science Committee.

I want to clarify a point as well, and Members should understand, I think Members of the T&I Committee, certainly the Aviation Subcommittee understand, the restructuring of how the acting Administrator handled the restructuring of JPDO within the FAA, I still have questions as to if it is the most efficient way to go about and prioritize and to make NextGen a real priority within FAA.

You know, we held a number of hearings, a lot of meetings, a lot of round-table discussions not only with the FAA but also all of the stakeholders. The people in the end will have to run the system, the people in the end who will be affected by the system and the airlines, general aviation, many others. And we came up with what I thought was a very good bill in the H.R. 2881, which passed the Committee unanimously, both Subcommittee, Full Committee, and passed through the House of Representatives.

And one of the things that we did in that bill was to elevate the head of the JPDO and to have that person report directly to the FAA Administrator, and we did it not based upon what we thought was best but based upon what all of the stakeholders thought was best, including, I don't want to speak for Dr. Dillingham and the IG, but others, with all of their input we felt that if we are going to get this major project done, that the JPDO person had to report directly to the FAA Administrator.

Not only did that not happen, after the bill passed the House on September 20 of 2007, there was a restructuring within FAA that we found out about by reading it in the newspaper as Members of this committee did. We were not consulted, either the Majority or the Minority in the Aviation Subcommittee or the Full Committee.

And when we had a meeting to determine why the FAA would move in this direction, which is contrary to what the stakeholders told us was the best system to move to and what the will of the House was by voting for H.R. 2881, we were told that they thought internally that this was the best way to move forward. At that meeting I must tell you the head of the JPDO, who is sitting right here in the front row, Mr. Leader, I asked him the question, I said, were you consulted about this? You are the head of the JPDO, and he said, no. No one talked to me about it.

So I asked Mr. Krakowski, who is now the head of the Air Traffic Organization, I said, you didn't consult with the head of JPDO to find out what their input would be, how it would affect them, what they thought? No. And I said, why not? He said, because Mr. Leader was out of town. And I said, so, how long was he out of town, and he said, for the last week. I asked Mr. Leader. He said I was out of town for the last week. So I said, so you put all of this reorganization together in five working days? Well, no, they had been working on it for a few months.

And it is one of the problems that we are facing, not only with NextGen but with a number of other problems and issues within the FAA. They have a long record of not consulting with stakeholders, people who run the system, people who, in fact, are affected by the system.

So I wanted to clarify that. It is not a question for Ms. Cox. She is not the person who made those decisions, but I want to tell you that I think it was a major mistake the way that it was restructured, and I believe that if, in fact, we are going to get this job done, to go to a satellite-based system, that the JPDO head should be reporting directly to the FAA Administrator. I think all of the stakeholders would tell you that. They told us that, and that is the reason that we put it in the reauthorization bill.

I am pleased on a positive note that as Dr. Dillingham indicated that for the longest time the FAA, they were moving forward, putting NextGen together without consulting the air traffic controllers and others who in the end will have to run the system. It was a recommendation by I think Dr. Dillingham and General Scovel, it was a recommendation certainly of the Subcommittee, and finally, they are now consulting with some of the stakeholders.

But I have to tell you that we have a lot of questions about where we go from here, questions about the agency's ability to undertake a project of this magnitude. You are talking about a project that the estimates run all the way up to $20, $25 billion to implement between now and the year 2025. The IG back in April of this year said to the FAA, you have long-term goals. We know where you are today, we know where you want to be in 2025, but what are your short-term goals and give us some reports as to where we are today. Give us a gap analysis, give us an interim architecture, and that was the IG's recommendation.

So we had at a meeting yesterday very briefly with Ms. Cox, and she tells me that both the gap analysis and interim architecture should be done by the end of the year.

But I have major concerns about how we are headed. I think that we have to provide very aggressive oversight, both this committee and the Aviation Subcommittee, in order to not only make certain that the project stays on track but that we monitor it in a proper way and not from the standpoint of is it on track, is it moving to the goal that we want to achieve. But also the cost.

This project has been going on for many, many years, not only under this Administration but previous Administrations. A lot of time and billions of dollars have been spent on this project, and we have very few results to show for it.

So it is my hope that this Full Committee as well as the T&I Committee will continue to provide aggressive oversight and to work with the FAA on NextGen.

And with that, Mr. Chairman, I know I exceeded my time. Thank you.

Chairman GORDON. Thank you, Mr. Costello. I certainly concur with you. And Dr. Gingrey is recognized.

Mr. GINGREY. Mr. Chairman, thank you. I will address my question to Ms. Cox.

In your written testimony you raise I think two very interesting points, and I would like to explore those with the Committee. First,

you testified that NextGen is not simply about air traffic capabilities but also about fostering improvements in ground infrastructure, aircraft technologies, and most importantly I think, alternative fuels. And then later on you note that the airline industry sees about 40 percent of its overall costs spent on fuel. Maybe it is more than that now, growing all the time, and the FAA, of course, has taken a very active role in Commercial Aviation Alternative Fuels Initiative, which includes testing on both coal to liquid fuels and gas to liquid fuels.

Our Ranking Member Hall, of course, discussed that a little bit with Dr. Waitz in regard to coal to liquid technology. And saying that, I find it troubling that this Congress seems to handcuff these efforts with a section in the Energy Independence and Security Act of 2007, which was passed last year, and I am referencing, Ms. Cox, Section 526. I am sure you are familiar with that section, but it explicitly prevents the Federal Government, any agency actually, any agency of the Federal Government, including, Dr. Waitz, the Department of Defense and within the Department of Defense the United States Air Force, which is using most of the fuel in our air fleet.

But this section prevents any agency of the Federal Government from contracting for the purchase of any alternative fuel if it results in one scintilla increase in the carbon dioxide footprint. Dr. Waitz has great concerns about that, and it seems to me in his testimony to be sympathetic with maybe the EU's approach to climate change and the Kyoto Protocol and that sort of approach.

It seems to me that that kind of policy is misguided especially when we are on a time of great dependency, great dependency on other countries for our fuel. And that it, indeed would stymie the efforts of the FAA in undertaking with NextGen and developing alternative fuels. And so to that end let me ask you two specific questions. First, because of these high fuels costs can you provide the Committee with the progress of testing coal to liquid fuels within its role in NextGen?

And the second question I have for you is this. Please answer this one yes or no if you will. If the Federal Government is supposed to take the lead on alternative fuels, then isn't Section 526 of the Energy Independence and Security Act of 2007, a roadblock to innovation for NextGen? And if there is time remaining, I would like to ask maybe Dr. Waitz to comment on that as well.

Ms. COX. Thank you for the question. In terms of progress in alternative fuels, the FAA continues its investment in the program through the CAAFI work that we are doing that Dr. Waitz referenced. I would defer to his superior knowledge on the progress of testing in the coal to liquid fuels. I am not an expert in that area, and I know that Dr. Waitz is the expert in that area.

We remain committed to finding an alternative fuel that does reduce the carbon footprint, and to that end we have increased our investment overall in the environment with our R&D budget by a great deal between '08, and '09. Over our environmental investment has gone up 135 percent, and of the total R&D budget our investment in the environment is a full, a little over 10 percent of our entire R&D budget, which this committee is very familiar with.

So we remain committed to—and we are encouraged by the progress that is being made, and in fact, we think that 526 sets a bar that we probably need to meet in terms of carbon dioxide. But, again, I defer to——

Mr. GINGREY. Well, let me just say this, and I know my time is limited and maybe won't get back to Dr. Waitz and maybe we can in a second round. But when you tell the agency, the Federal Government, particularly the Department of Defense that don't bother to contract for any alternative fuels other than conventional bubble-up petroleum jet fuel, that they are not going to be able to use it, so that certainly puts a damper on their enthusiasm for conducting the research on things like coal to liquid, carbon sequestration as Dr. Waitz said. That is the very research that we are trying to do within NASA and Department of Defense. And it is just counterproductive.

So I see my time has expired, Mr. Chairman. I, maybe I will have some time in the second round.

Chairman GORDON. Thank you, Dr. Gingrey. I do have some good news for you. In that same act that you pointed out, this committee put in that Energy Bill an extensive program on carbon capture and sequestration, which is the basis for any type of coal to liquid or anything else as Dr. Waitz pointed out.

So the first step is being taken. You can't do the second until you get the carbon sequestration. This Committee played a big role in that program.

Ms. Edwards, you are recognized.

Ms. EDWARDS. Thank you, Mr. Chairman.

NEXTGEN BUDGET AND EDUCATION ISSUES

Dr. Kaminski, in your testimony you advocated securing systems acquisition, systems engineering, and integrated management talent at FAA and other agencies as part of accelerating NextGen. And so I am really curious given today's competitive environment, competing needs at other agencies, what you think the FAA can do to distinguish itself and particularly looking, and then to Ms. Cox, looking at the budget allocations for projections for the current fiscal year and the out years, a doubling and then a tripling of the budget for NextGen and what the plans really are within the FAA to be able to both acquire the talent in house that it needs to oversee this kind of project, and you know, where the plans might be, particularly Dr. Kaminski, for reaching that kind of talent, given the competition from other agencies and even in the private sector.

Dr. KAMINSKI. That is a very good and important question, and when we look at the funding that the country is going spend for this program over a 20-year period, my estimate would be something approaching $100 billion when we start to look at all of our equipage issues, including the private sector investments that will be made in a corresponding way.

So this is a big deal. This is a big and important and large, complicated program. And to get to your question to training the people, what I proposed in the briefing that I submitted for the record, is an approach that involves building a little, testing a little, developing, modeling, and simulation tools to be able to predict how this system will work.

Those are going to be a very important foundation for us to have as we look at new capabilities over time. We also have the problem of what I would describe as changing the tire on the car that is going 60 miles an hour, because we are going to have to implement these improvements as we are moving along, having modeling and simulation that we validated by demonstrations is going to be very critical for us to be able to do that.

The modeling and simulation and the demonstrations that I propose also are a superb training ground for people to gain some domain experience in what is going on. Education is required, but domain experience is also required in this process.

So it is going to be very important for us to build that base. I do not believe that entire base is present today at the FAA. I think the FAA is planning to try to build that base, but it will be a challenge.

And then to your last question, one of the incentives to attract people to this kind of activity, I don't believe they are only going to be financial incentives. In my experience in the DOD what I have found is that it is possible to attract best and brightest people to government and to industry and this kind of activity, but keeping them depends upon providing them with real challenges, providing them with the tools to address those challenges, and most importantly allowing them to see that they can make a difference, that they can change the world, they can change the infrastructure of our country in important ways. That is the fundamental attractor.

Ms. EDWARDS. Well, it certainly has to be interesting work, and then Ms. Cox, can you address the budget concerns? Because I am just, I think that kind of growth is really significant, and I am not really sure what you have in house to manage that kind of growth.

Ms. COX. Yeah. Thank you for the question. It is a very good one. In response to the systems engineering issue, I can say that we are growing some of that talent in house. Fifty-seven employees in the air traffic organization have received certificates in graduate systems engineering disciplines, and we have 60 employees who are currently enrolled in certificate programs in systems engineering. So we gain some in that way.

We are concerned about systems engineering and other technical skills such as information technology specialists, automation specialists that we will need going forward to support the level of work that you point out that we have. We have hired within the NextGen and operations planning organization over the past year 78 new employees, most of whom came from outside the FAA. One way we attract people is as Dr. Kaminski has pointed out through the very, this is a very exciting program. This is a real opportunity to make a difference, and I think that is very attractive to folks, especially recent graduates just entering the workplace, and that is a group that we do want to attract.

We believe that we are going to need to hire on the level of 300 more in-house professionals in addition to the assistance that we can get through external sources such as federally funded research and development corporations and other external opportunities to bring people on board.

And we are working closely with our human resources organization to be sure that they have the resources on hand to help us recruit and bring in those people. And as Dr. Kaminski points out, the methods to retain the people once we get them.

Chairman GORDON. Thank you, Ms. Edwards and Ms. Cox.

Dr. Ehlers, you are recognized.

Mr. EHLERS. Thank you, Mr. Chairman. I think I have spent entirely too much time with some of you in the past two days, but I enjoyed it.

FAA HIRING

Ms. Cox, continuing with some of this discussion, I voiced yesterday in one of the two meetings we had my concern about NASA involvement and that they don't seem to have the funding or the personnel to do it. Now, you are taking on more and greater research and development responsibilities as a result, aren't you, in the FAA? And your last comment about the number of people you are adding, is that to fill that gap? Is it specifically directed to what NASA might ordinarily have done, or are there other factors here as well?

And I am also wondering if you have the flexibility you need to do the hiring? I know how convoluted hiring practices can become in the Federal Government. Obviously you need these people fairly quickly, and I am wondering if you are having any difficulties with that and whether you will be able to find the mix of skills that you need in the time that you need them.

Would you just give me some idea on that?

Ms. COX. Well, as we pointed out, we do need people to help us manage the work that the budget request reflects that we will need to be doing to achieve NextGen. So the hiring is around that, and that includes the additional R&D work that we anticipate doing to support NextGen. We have been working closely with the human resources organization at the FAA to address this issue of the difficulty of bringing people on board.

We had pretty good success. Seventy-eight people in just our organization in the course of a year, most of them coming from outside, is a pretty good record for the Federal Government in hiring. The FAA, as you know, has some flexibilities in that area that we are looking at how to utilize and take best advantage of.

I am not sure that we have always taken best advantage of those efforts in the past, but we are looking at, we have lots of room for innovation and moving ahead. So we hope to do that.

Mr. EHLERS. Well, if I lose my election, I may be applying as well.

GAP ANALYSIS FINDINGS

Also, the gap analysis that you mentioned. You stated that JPDO completed a gap analysis. Could you expand just a little bit on the findings? What areas need focus, how will you handle it, how will the partner agencies handle it?

Just if you can give me sort of an overall picture of what the gap analysis revealed and how you are going to handle it.

Ms. COX. Well, the gap analysis was an effort by the Joint Planning and Development Office, and they work closely with MITRE to assess what was in the Integrated Work Plan and what is in the plans of the partner agencies of JPDO. They found seven critical areas that they believe require additional focus. Those include the environment, and we have had quite a bit of conversation about those issues today. Security risk management is another area. Validation and verification of complex systems. You know, we are introducing something kind of new and different with this, and it is a very complex undertaking. Validation and verification of what we are doing is going to be extremely important. Then they looked at some air traffic issues that go to kind of specific areas.

One is closely spaced parallel runways. Ten of the 35 OEP airports have closely-spaced parallel runways, and we need to get greater capacity out of those. So that was another key area that they identified.

How to integrate arrival and departure traffic with surface traffic was another area that they identified, and also this issue of air to ground functional allocation. What is the role of the pilot, what is the role of the controller in the NextGen environment? That needs more work to be addressed, particularly with the human factors issues that are involved with that.

And finally, the JPDO or the NextGen Enterprise Architecture, the Enterprise Architecture that rolls up the work of all the individual partner agencies into a single architecture for NextGen, the validation of that and developing a business case around that was another issue.

Obviously, the air traffic issues fall under the province of the FAA and NASA in terms of some of those it required the, some research and development to move us forward. DHS with security risk management and the JPDO with the Enterprise architecture issue.

Chairman GORDON. Thank you, Ms. Cox, and——

Mr. EHLERS. May I just make a comment?

Chairman GORDON. Okay. Yes.

Mr. EHLERS. I just want to say I have been very, very concerned about the entire NextGen Project, and I wasn't sure that we were going to, that you and we were going to be able to pull it off in a timely fashion at a reasonable cost. I must say I am pleased with the progress made, and I am starting to feel much better about the project now, and I am addressing that not just to Ms. Cox but to all of you.

I think you are making substantial progress in the right direction. I still have a lot of concerns but I would be crazy if I didn't have concerns about a project of this magnitude.

Thank you for the work that you are doing.

Chairman GORDON. Thank you, Dr. Ehlers. You know, there has been a lot of discussion about costs, so I think it is appropriate that we talk to an appropriator here and so Mr. Rothman, let me just say, again, there is a 9/11 memorial getting ready to start, and so Mr. Rothman will be our last witness. Our other—our last Member to ask questions. Any other Members that have questions they can be submitted for the record.

Mr. ROTHMAN. Thank you, Mr. Chairman. Thank you for holding this very important hearing. I want to, I am speaking quickly. I have five minutes. I want to acknowledge and express my appreciation to the panel for their expertise and for their service to our country. You have distinguished careers, each and every one of you.

I want to say a couple of things real fast. It was noted that air traffic controllers are being a part of the NextGen, and that is a great thing. Please keep that up. If there, in fact, is a need for more input from safety technicians, I hope the people responsible will address that.

I also would hope that citizens groups who are involved in quality of life issues and noise in particular, but also emissions over their homes and their barbecue grills will also be consulted as NextGen is developed.

One other pet peeve, wondering why small trainers or propeller planes are still permitted to fly over densely-crowded populated areas. I don't think we are allowed to bring horses and buggies into, through tunnels and bridges into the major density populated areas of a country. So I don't think—I think these trainers and small prop planes should be prohibited from flying over densely-populated areas.

So I hope that those who will have jurisdiction over that area will address it.

OVERCROWDING OF THE SKIES

But here is the point I or the question I want you, the panel, to consider. I would like to hear first from Dr. Waitz, but I would be interested in everyone's views assuming there is time. And I am very grateful that you are working on noise issues and emissions issue. It is really important, and as Dr. Waitz said, that is a limiting factor on expansion of airports but beyond that it has to do with the lives of five million people, and I think that number is rather low.

So thank you, keep that up, and I will be paying attention.

Let us assume that we make a quiet airplane, perfectly silent, and God willing that will happen some day. How do we feel about the sky over our head being filled with aircraft? You know those pictures of World War II, the bombing of Dresden and the sky filled with aircraft. Now, granted, I understand that the effort is to have the planes fly higher and so all of that, but let us reduce it to the extreme or the absurd if you will. To find out the nature of your thinking, do we want a society or a world where our skies are completely filled with aircraft, even if they are silent and there is no dangerous emissions coming from them?

Dr. WAITZ. I remember the first airplane my dad bought me when I was four. So you are asking the wrong person. Blue with yellow wings. I look up every time I see one. I think it is just an important part of providing, you know, goods and services and movement of people. And the sky is not so filled with airplanes when you look at how much sky there is.

Mr. ROTHMAN. Where do you live, Dr. Waitz?

Dr. WAITZ. I live in Boston. Yeah. So, no, my feeling is that, you know, airplanes are an important part of our modern life, and I value them.

Mr. ROTHMAN. Anyone else have any comments?

Dr. DILLINGHAM. Mr. Rothman, I think that there is a recognition of the concern about a situation that you described, and to address that there is also initiatives or thinking about an intermodal approach to transportation. So, you know, your concerns are widely shared, and there is, there are efforts about to do something about them.

Mr. ROTHMAN. Great. I just can say that there will be resistance to filling the sky with planes.

Thank you, Mr. Chairman.

Chairman GORDON. Thank you, Mr. Rothman. Although Mr. Hall wanted me to point out that in Texas you can bring horses and buggies in on the roads and into the bridges, again, thanks to our witnesses. I am sorry we had to be somewhat abbreviated today. I know I have some and I think other Members will have some additional questions for you, and I would like to now pass the gavel to Mr. Hall to adjourn us for this session of Congress.

We are adjourned.

[Whereupon, at 11:35 a.m., the Committee was adjourned.]

Appendix 1:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Victoria Cox, Senior Vice President for NextGen and Operations Planning, Air Traffic Organization, Federal Aviation Administration

Questions submitted by Chairman Bart Gordon

Q1. Automatic Dependent Surveillance Broadcast (ADS–B) is intended to be a cornerstone of the NextGen system. However, I understand that FAA received strong criticism in response to its proposed ADS–B rule-making for user equipage. Users expressed concern that mandating equipment on board aircraft would provide only the ADS–B "out" service, where signals transmitted would be used primarily by the air traffic control system to get new data on aircraft positions. Some operators viewed the mandated ADS–B "out" equipage as providing them with little or not benefit, either operationally or financially. While FAA no doubt will benefit from ADS–B, push back from the intended users shows that they have yet to be persuaded.

Q1a. What commitments, such as a reduction in delays or lower fuel consumption, could FAA make to convince users of the positive benefits of equipping with ADS–B "out"?

A1a. The following table summarizes the benefits for the Air Transport community (note: ADS–B 'Out' benefits are highlighted in yellow, ADS–B 'In' benefits are highlighted in green, and both 'In'/'Out' benefits are highlighted in orange):

Location	Application	Outcome	Risk Adjusted PV $M
CONUS, Hawaii, and Caribbean Surveillance	Radar Airspace ATC Surveillance	Reduction and more efficient maneuvers in response to URET	$801.8
		More efficient metering based on improved TMA accuracy	$417.0
		Increased safety on the surface by controllers	$3.2
		More efficient ATC management of surface movement	$26.9
CONUS, Hawaii, and Caribbean Aircraft Applications	Enhanced Visual Approach - Initial Application	More efficient spacing on approach in VMC	$300.4
	Enhanced Visual Approach - CAVS	Continuation of Visual Approaches in marginal conditions	$196.4
	Enhanced Visual Approach - Merging and Spacing	Increased ability to allow continuous descent approaches	$796.0
	ADS-B ATC Automation Integration		
	Airport Surface Situational Awareness	Increased safety on the surface by pilots	$70.5
	Final Approach and Runway Occupancy Awareness		
Gulf of Mexico Surveillance	Non-radar Airspace ATC Surveillance (includes weather and comm as needed)	High Altitude - Increased Capacity	$459.3
		High Altitude - Optimal Routing	$86.5
Alaska Surveillance and Broadcast Services	Non-radar Airspace ATC Surveillance	Increased IFR capacity (JNU)	$1.1
Total			$3,159.1

The following table summarizes the benefits for the General Aviation community (note: ADS–B 'Out' benefits are highlighted in yellow, ADS–B 'In' benefits are highlighted in green, and both 'In'/'Out' benefits are highlighted in orange):

Location	Application	Outcome	Risk Adjusted PV $M
CONUS, Hawaii, and Caribbean Broadcast Services	Enhanced Visual Acquisition and Conflict Detection	Fewer aircraft-to-aircraft conflicts	$203.6
	Weather and NAS Status Situational Awareness	Fewer encounters with hazardous weather	$232.5
		More efficient routes in adverse weather	$4.9
		Reduction in user costs to obtain weather info	$26.1
		Fewer aircraft-to-terrain conflicts	$284.3
Alaska Surveillance and Broadcast Services	Weather and NAS Status Situational Awareness and Enhanced Visual Acquisition and Conflict Detection	Fewer aviation accidents in Alaska	$300.1
	Non-Radar Airspace ATC Surveillance	Access to lower altitude routes in Alaska	$19.5
		Fewer aircraft-to-aircraft conflicts (JNU)	$0.0
		Improved search and rescue services in Alaska	$7.0
Alaska Airport IFR Upgrade Services	Weather Automation upgrade and IFR Approach Development	Increased access to remote villages in Alaska	$90.0
		Increased Medevac access to remote villages in Alaska	$175.4
Total			$1,343.4

Reduction in delays or lower fuel consumption:

United Parcel Service (UPS) has been an early adopter of ADS–B technology; they have equipped some of their aircraft and have seen both increased efficiency and lower fuel burn in their operations. For example, they have seen a 30 percent reduction in noise, a 34 percent reduction in nitrous oxide emissions and 250 to 465 pounds less fuel burn per flight.

Additionally, the agency is working to develop performance routes in the National Airspace System (NAS) for ADS–B equipped aircraft. This would enable direct routing which translates into increased efficiency for the airline/aircraft operations. By providing these routes it would also lower fuel burn since the aircraft would be flying at optimal altitudes and optimal routes.

Q1b. When will ADS–B "in" become available, especially given its potential for helping prevent runway incursions?

A1b. ADS–B is available today and the FAA is encouraging users to equip by providing ADS–B in applications such as advisory services. The FAA is currently providing Traffic Information Service—Broadcast (TIS–B) and Flight Information Service—Broadcast (FIS–B) to ADS–B equipped aircraft in Southern Florida. TIS–B will show pilots the same display of air traffic that controllers see. The FIS–B products will provide graphical displays of National Weather Service products and essential flight information, such as special-use airspace and temporary flight restrictions. TIS–B and FIS–B are a part of the service that supports ADS–B 'In.'

As a part of segment one deployment the FAA will be providing these services (TIS–B and FIS–B) along the east and west coasts, and portions of the mid-west by 2010. As for segment two, the plans are to provide the same services everywhere there is radar coverage today by 2013.

Q1c. What specifically is FAA doing to accelerate transition to early equipage of ADS–B? When could we see the job completed?

A1c. The FAA has been working with Industry through the ADS–B Aviation Rulemaking Committee (ARC) to accelerate early equipage of ADS–B. Specifically, two of the ARC recommendations focus on benefits/equipage:

- Recommendation #9: Leverage the benefits of ADS–B information to incentivize equipage by establishing agreements with specific operators.
- Recommendation #10: Continue to establish agreements with local and State governments to leverage the benefits of ADS–B

Since that time, the FAA has held the following meetings to determine potential incentive mechanisms to include in potential agreements:

- January 2008: NetJets, American Airlines, FedEx
- April 2008: Continental Airlines, DayJet, Wisconsin Department of Transportation, Minnesota Department of Transportation
- May 2008: DayJet Follow-up
- June 2008: Follow-up with American Airlines, California Department of Transportation

- July 2008: Additional Follow-up with American Airlines, United Airlines
- October 2008: USAirways

The following table incorporates the feedback from these meetings to show what may incentivize users to equip early.

Category	Application	Outcome	Benefit
Safety	Enhanced Visual Acquisition, and Wx and NAS Status Situational Awareness	Fewer Aircraft to Aircraft Conflicts Fewer Encounters with Hazardous Weather	Minimize Fatalities, Injuries, and Aircraft Damage
	Airport Surface Situational Awareness and Final Approach and Runway Occupancy Awareness	Fewer Runway Incursions and Accidents	Minimize Fatalities, Injuries, and Aircraft Damage
Efficiency / Capacity	Enhanced Visual Acquisition and Visual Approach	Continuation of Visual Approaches in Marginal Conditions More Efficient Spacing during Visual Approaches	Minimize Interarrival Spacing and Maximize Peak Airport Arrival Throughput
	Enhanced Surveillance in Radar Airspace	More Efficient En Route Metering to Arrival Fix (improve TMA performance)	Minimize Flight Times from Extended Terminal Area to Runway
		More Efficient En Route Conflict Resolution (improve URET performance)	Minimize Distance and Flight Times associated with Conflict Resolutions
		Provide Access to Parallel Runways when Not Otherwise Available	Maximize Peak Airport Arrival Throughput and Minimize Delays due to Terminal Congestion
		Provide Access to Performance Routes	Minimize Ground Delay (e.g. East Coast routes)
	Surveillance in Non-Radar Airspace (NRA)	More Efficient Separation on Approach	Maximize Peak Airport Arrival Throughput and Minimize Delays due to Terminal Congestion
		More Efficient Separation En Route	Maximize En Route Sector Throughput
	Distribution of Surface Surveillance to AOCs	Improved Asset Tracking/Resource Scheduling	Prioritize Critical Flights in Taxi Queue, Optimize Personnel Utilization
User Cost Savings	Synergize Capabilities within Avionics	Replace Existing Functions (GA ELT / Transponder)	Reduce Cost of Ownership
	Government Financial Incentives	Shared Costs, Tax Incentives, Grants, Interest Free Loans	Reduce Cost of Ownership

Q2. The terrible events of September 11, 2001 remind us of the potential consequences of the malicious misuse of the Nation's aviation system. As you know, by using ADS–B, NextGen will be able to monitor the precise location of aircraft in the national airspace, but only if those aircraft cooperate and emit the needed signal.

Q2a. In the NextGen era, will there be a continuing need for DOD and DHS to maintain radar surveillance to guard against a situation where a terrorist-operated aircraft does not transmit ADS–B signals so that it can fly unobserved?

A2a. The surveillance requirements for the national air transportation system are continuing to evolve. While ADS–B will offer considerable benefits in terms of system operations there are additional security and national defense concerns that require consideration. The Department of Homeland Security (DHS) and the Department of Defense (DOD) have both expressed the need for continued primary, non-cooperative radar capabilities.

Q2b. If so, have the FAA and other agencies determined how that radar surveillance capability will be provided? How will it be provided?

A2b. Successfully addressing this issue requires a multi-agency perspective. In its cross-agency coordination role NextGen's Joint Planning and Development Office (JPDO) has established a joint Interagency Surveillance Study Team (ISST) with the DOD, the DHS, the Department of Transportation, the Federal Aviation Administration, and the Department of Commerce to address the issue.

Q2c. What requirements are DOD and DHS levying on the NextGen system for radar surveillance?

A2c. The ISST has recommended the establishment of a formal and institutionalized mechanism for the management and ownership of the Nation's integrated surveillance capabilities. Under this approach future national aviation surveillance information requirements can be analyzed holistically. This comprehensive approach will ensure that the responsibilities and requirements of key stakeholders are addressed.

These proposals have been presented to the JPDO's Board of Directors and will shortly be considered by the NextGen Senior Policy Council.

Q3. A few weeks ago, an internal software processing error in FAA's NADIN system grounded hundreds of flights. Evidently an aging back up system got overwhelmed and hundreds of planes could not get off the ground. In drafting H.R. 2698—legislation authorizing FAA's R&D—this committee explicitly singled out the need for contingency plans in designing NextGen. Specifically, the Director of JPDO was directed to develop contingency plans for dealing with the degradation of the air traffic control system in the event of a natural disaster, major equipment failure, or act of terrorism.

In developing NextGen, which is a system of systems, how is the need for redundancy and backup capability being addressed?

A3. Business Continuity is a fundamental requirement in NextGen. The limitations imposed on our systems, such as computer processing, communications over copper phone lines, and old protocols for exchange of information, are being removed. Air traffic management, communications, navigation, surveillance services are provided in a more seamless, flexible fashion than today. Network enabled services will provide greater system resilience, and the opportunity to handle demand more effectively. The flexibility these systems provide for reliability and backup also provide the flexibility to better manage weather events and other perturbations to the NAS that cause delays and reduce service levels.

The NextGen transformational programs especially System Wide Information Management and NAS Voice Switch, along with FTI, provide much of the infrastructure needed to move networked enabled services forward. These systems enable the information sharing between facilities that is an essential element of NextGen: dramatically improving situational awareness, maximizing collaborative planning, and minimizing the impacts of weather and system outage on capacity. Air traffic services will no longer be directly tied to a legacy, static information infrastructure.

Q4. How is budgetary and program accountability assigned in the new ATO restructuring? In other words, who has control over the budget of an acquisition such as ADS–B or SWIM that will be critical to the success of the NextGen initiative? Who is in charge of those programs?

A4. The Sr. Vice President for NextGen and Operations Planning has responsibility for all elements of the NextGen portfolio, including the transformational programs (i.e., ADS–B, SWIM, NNEW, Datacomm, and NVS). The NextGen Integration and Implementation (I&I) Office, reporting to the Sr. Vice President for NextGen and Operations Planning, is responsible for developing and managing the FAA NextGen Implementation Plan, and the budget that supports it. Individual NextGen programs such as ADS–B and SWIM are assigned to program offices as part of the investment decision. The individual program offices retain the responsibility for meeting program expectations and for managing their programs in accordance with timelines and milestones established with the I&I Office and the FAA's Acquisition Management System. The Senior Vice President for NextGen and Operations Planning is responsible for overall management and alignment of all NextGen projects.

Q5. The DOT OIG recommended earlier this year that FAA develop an interim architecture or "way-point" that is manageable and executable for what is expected in 2015. The OIG report says that FAA concurred with this recommendation.

Q5a. When will such an interim architecture be completed?

A5a. The FAA concurs with the recommendation to develop an interim National Airspace System (NAS) architecture that defines a way-point on the path to realizing NextGen and the "To Be" enterprise architecture. The development of an interim architecture and the associated requirements will provide a mid-term goal for the implementation of key NextGen capabilities that reduces far-term schedule risk.

The annual update of the FAA's NAS Enterprise Architecture Roadmaps will be published in January 2009. These architectural updates will be reflected in the next version of the FAA's NextGen Implementation Plan, which is also scheduled for release in January 2009. These documents outline the FAA's activities for implementing near-term and mid-term NextGen capabilities into the NAS.

As part of this year's roadmap updates, several new activities and features are being incorporated to enhance the usability and effectiveness of the roadmaps and to support the definition of the mid-term architecture.

First, we worked with the JPDO to ensure alignment of the Operational Improvements between the JPDO's planning documents and the FAA's Enterprise Architecture. Each of the Operational Improvements were then mapped to functions and projects by phase: near-, mid-, and far-term. The results of this mapping activity are being transferred to the roadmaps as part of this year's update process. This align-

ment work will allow a more precise definition of the mid-term architecture, capabilities and functions, and the associated projects necessary to realize the NextGen benefits including the critical capabilities to be realized in the mid-term.

Second, we initiated efforts to integrate key supporting activities such as research and development, prototypes and demonstrations, international initiatives, and other activities into the EA roadmaps. This will provide greater insight into schedule dependencies, policy issues, transition readiness criteria and associated risks, and identify any gaps between these supporting activities and Agency projects and programs that need to be addressed to reduce implementation risk for NextGen. We are also ensuring that we fully capture all legacy systems in the EA so that we can properly identify convergence strategies as we migrate from the current portfolio of systems to NextGen.

Third, new roadmaps are being developed to provide greater visibility into key areas of the NextGen mid-term architecture such as airspace design and procedures, service oriented architecture, network-centricity and inter-operability, as well as to identify impacts on personnel, security, and safety. These new architecture "views" will be aligned with existing EA products to provide a more complete definition of the mid-term architecture.

These initiatives taken together will provide the basis for a complete definition of the mid-term architecture and enhanced insight into the evolution of NAS changes necessary to realize NextGen.

Q5b. How will it affect the long-term NextGen implementation schedule?

A5b. A more complete definition of the mid-term architecture based on the initiatives described in the previous response will enhance our ability to accomplish long-term objectives. Therefore, it will positively affect the long-term plans for NextGen and reduce far-term schedule and implementation risk.

As previously mentioned, we worked this year to align the Operational Improvements between the JPDO's planning documents and the FAA's NAS Enterprise Architecture. Early next year, we have plans to continue this effort by focusing on the far-term Operational Improvements and the associated research activities needed to reduce far-term schedule risk. We will continue the efforts initiated this year to align R&D activities within the EA roadmaps and look for gaps and opportunities to more closely align R&D with project acquisition strategies.

In addition, we have plans over the next several months to supplement the existing enterprise architecture with new views that will provide greater insight into the "To Be" architecture. These views will provide additional information and detail into important aspects of the architecture needed to reduce long-term implementation and schedule risk.

Q5c. Are you still committed to the release of an updated Integrated Work Plan by the end of September 2008?

A5c. This action is complete. The Joint Planning and Development Office (JPDO) released *The Next Generation Air Transportation System Integrated Work Plan: A Functional Outline (Version 1.0)* in September 2008 as planned. The Integrated Work Plan (IWP) provides a tool to support the collaborative planning and deliberation needed among partners and stakeholders to prioritize needs, establish commitments, coordinate efforts, and focus resources on the work needed to achieve the Next Generation Air Transportation System (NextGen). The IWP is a functional plan that outlines the proposed building blocks towards achieving the NextGen vision. NextGen will be realized through the research, development, and implementation investments that are funded and managed by each NextGen Partner. The JPDO works with all NextGen Partners to align their investments towards achieving the overall NextGen vision. IWP Version 1.0 conveys the JPDO's current understanding of Partner efforts and presents the suggested alignment of NextGen planning elements with each Partner's mission areas. It is important to note that the IWP is an unconstrained plan and does not seek to define prescriptive implementation activities, nor does it address priorities of activities at this time. It proposes a path to realize the IWP elements but not the specific program steps, resources or implementation elements such as facility roll-out, training, or decommissioning. The detailed planning for each IWP element is the responsibility of the NextGen Partner that has accepted the element as part of their overall mission. For more information and to view the IWP Version 1.0, visit *www.jpdo.gov*.

Q6. I understand that DOD and DHS have failed to identify their respective future NextGen-related FY09 budgets to JPDO.

Q6a. Has this issue been broached at Senior Policy Committee meetings?

A6a. The issue of shared responsibility between the Department of Commerce and the FAA for NextGen weather initiatives has been discussed at the SPC. The Department of Defense is sharing weather information already funded and underway as part of their core program. Joint weather programs are by far the most mature of the JPDO's interagency collaborations.

Q6b. Why have these agencies not identified their expected contributions?

A6b. The DOD and DHS have both been working with the Joint Planning and Development Office to identify their respective NextGen requirements. The DOD, with the Air Force as the lead service agency, is now actively involved in the development of NextGen. This includes net-centric operations development, weather research, and demonstration efforts planned for 2009. The Air Force leads the net-centric division at the JPDO and will shortly be assigning a senior executive who will be responsible for the DOD-wide NextGen initiative. The DOD has provided fiscal year 2008 funding in support of the net-centric effort.

DHS also maintains a full time presence at the JPDO and contributed to the ConOps by developing a separate Security Annex. They also provided substantial input to the NextGen Integrated Work Plan (Version 1.0). DHS is also providing funding, along with the FAA and DOD, for the Network Based Operations Demonstration. Further, in an effort to accelerate its participation in NextGen, DHS is using the Florida area (also a site for several FAA airspace related NextGen demonstrations) to demonstrate its "Project 6" which involves a number of closely related evolutionary checkpoint security initiatives. This includes a perimeter intrusion detection system, an emergency management operations controls system, and unified air cargo tracking. The intent of this work, which supports the JPDO goal of a curb-to-gate approach, is to expand capabilities to other locations and then throughout the United States.

Q6c. How have their omissions impacted NextGen plans and schedules?

A6c. To date NextGen plans and schedules have not been impacted.

Q7. Estimated costs for FAA investments needed to reach NextGen's end state in 2025 have been identified by the JPDO as being in the range of $15 billion to $22 billion. Regarding the cost of equipping aircraft with NextGen's avionics, the JPDO said "the most probable range of total avionics costs to system users" is $14 billion to $20 billion.

Q7a. How credible are these numbers?

A7a. The $15–$22 billion mentioned in the question was developed several years ago by a special JPDO/Industry team. These estimates are preliminary and were useful in gauging the initial magnitude of NextGen costs. Further, it should be noted that these estimates represented capital expenditures and not life cycle costs.

Q7b. What are the confidence levels associated with these estimates?

A7b. Because of the preliminary nature of both sets of estimates confidence levels were not used.

Q7c. If confidence levels were not used, what was the basis for the cost estimate ranges?

A7c. The data relied on broad estimates and approximations based on the level of operator participation.

Q7d. When will these numbers be updated and what confidence levels will they have?

A7d. As the requirements, program definition and scope of NextGen have continued to evolve, more accurate and comprehensive estimates are being developed. The same can be said of the estimates, noted above, regarding avionics costs.

Estimates now under development represent a much more structured and verifiable cost estimating process. All known NextGen programs and activities are being identified, their costs gathered or developed, adjustments, in terms of program maturity are being applied, and then the overall data is being evaluated for completeness. There will also be sensitivity analysis to account for changes in the aviation environment, demand, and funding levels. On this basis, it will be possible to apply useful confidence levels to programs with known requirements. It should be noted that requirements for many key NextGen programs such as Data Communications and System Wide Information Management as well as requirements for a common automation platform have not been established. This means that a final, highly

accurate cost estimate will not be available until these programs have fully developed requirements.

Q8. I understand the FAA plans to stand up an integrated test bed of NextGen technology near Miami to accelerate NextGen implementation.

A8. Background: We are already utilizing NextGen capabilities that have been established in the region such as the ADS–B infrastructure and capabilities established by Embry Riddle Aeronautical University and its partners. In addition, the test bed will include the use of performance-based navigation tools to obtain valuable information that will assist FAA in developing additional requirements, standards and procedures for operations in the NextGen environment while providing immediate benefits to targeted areas. These efforts will focus on Florida, the east coast, Texas and the Gulf of Mexico.

Q8a. Which NextGen R&D initiatives will be accelerated?

A8a. Provided below are the names, descriptions, associated NextGen Solution sets and the anticipated benefits for seven programs and projects we are demonstrating to accelerate NextGen implementation.

NextGen Demonstrations and Acceleration (10/01/08)

	Program / Project	Description	NextGen Solution Set	Anticipated Benefits
1	Continuous Descent Arrival (CDA)	Enhances Area Navigation (RNAV) / Required Navigation Performance (RNP) arrivals with optimized vertical profile	High Density Arrival/Departure Terminal & Airport; Safety, Security & Environmental	Reduced Fuel Burn - noise and emissions
2	Tailored Arrivals (Taps)	Integrate automation tools & Oceanic Data Comm to provide cleared trajectory path, data linked to the aircraft, and flown by the aircraft's Flight Management System (FMS)	High Density Arrival/Departure Terminal & Airport; Safety, Security & Environmental	Reduced Fuel Burn - noise and emissions
3	3-Dimensional Path Arrival Management (3-D PAM)	Initial move toward 4-D trajectory Management using voice in domestic airspace to provide a cleared trajectory to the flight deck to be entered and flown by the FMS	High Density Arrival/Departure Terminal & Airport; Safety, Security & Environmental	Move from multiple clearance to aircraft centric 4-D Trajectory Management
4	Oceanic Trajectory Based Operations (TBO) Proof of Concept	Additional toward 4-D trajectory Management	Trajectory-Based Operations (TBO); Safety, Security & Environmental	Increased fuel efficiency enroute -move toward aircraft centric 4-D Trajectory Management
5	Improved Weather Detection / Prediction Integrated with Traffic Management Advisor (TMA)	Improved weather detection and prediction passed to TMA, via System Wide Information Management (SWIM) network, to maintain arrival rates mitigating the adverts effects of convective weather	High Density Arrival/Departure Terminal & Airport Reduce weather Impact	Reduces delay caused by weather, improving on-time performance
6	Surface Trajectory-Based Operations at John F. Kennedy and Memphis International Airports	Leverage Airport Surveillance Detection Equipment-Model X (ASDE-X) installations to provide shared situational awareness and collaborative decision making between Air Navigation Service Providers and Air Line Ramp Towers	High Density Arrival/Departure Terminal & Airport; Safety, Security & Environmental	Collaborative airport surface management, Move toward surface TBO; Reduced fuel burn, and noise -Thus reduced environmental footprint
	John F. Kennedy International Airport	Shared Situational Awareness		
	Memphis International Airport	Collaborative Decision Making		
7	Network Enabled Operations (NEO)	NEO is a program directed at developing / leveraging an innovative, effective and efficient system-to-system operational architecture with supporting procedures, that will provide the FAA and its partners an agile, highly connective network for shared situational awareness.	Collaborative Air Traffic Management; Safety, Security & Environmental	Integration of "legacy" and "near-term" capabilities, leverage technology and investment in of civil transport organizations, to provide 'Net-Centric interoperability

Q8b. By how much time will they be accelerated?

A8b. The total time saved will be dependent on the success of these NextGen demonstrations (i.e., did the demonstration validate the procedure or new technology), and can the procedure or technology be successfully inserted in the National Airspace System (NAS) based on related legacy technologies, procedures, equipment and automation; and the arrival of newer NextGen technologies, procedures, equipment and automation. To the extent possible, every effort will be made to "bundle" developmental successes with other implementation efforts.

Q8c. What user benefits are being achieved earlier?

A8c. The anticipated benefits for the seven NextGen demonstration programs and projects are provided above. All of these have been accelerated.

Q8d. How will this translate into faster nationwide implementation?

A8d. The initial NextGen demonstration effort is directed at accelerating operational procedures in conjunction with established programs as follows:

- Establishing criteria for use of Continuous Descent Arrivals in higher density airports increases the individual development and effective use in a national roll-out
- Traffic Management Advisor (TMA), Conflict Probe, and RNAV/RNP for Tailored Arrival (TA) (also includes future domestic Data Communications) and 3–Dimensional Path Arrival Management (3–D PAM),
- Advanced Technology and Oceanic Procedures (ATOP) for Oceanic Trajectory-Based Operations (TBO) proof of concept demonstration,
- TMA and Enhanced Winds Aloft Product to provide Weather integration into TMA,
- Airport Surveillance Detection Equipment Model–X (ASDE–X) and multilateration with Surface Decision Support System (SDSS) development to provide "Shared Situational Awareness" and "Collaborative Decision-Making" between air navigation service providers (ANSPs) and airline ramp towers, and
- Development and/or leveraging innovative, effective and efficient system-to-system operational architecture with supporting procedures to provide the FAA and its partners with an agile, high connective network for shared situational awareness through the System-Wide Information Management (SWIM) network.

Q9. Two years ago, following a hearing on the National Academies' Decadal Plan for Aeronautics, Dr. Kaminski, in an answer for the record, characterized certification of new technologies as a key barrier. He said:

"As systems become more complex and non-deterministic, methods to certify new technologies become more difficult to validate. Core research in methods and models for assessing the performance of large-scale systems, human interactive systems, and non-deterministic systems, and complex, software-intensive systems, including safety and reliability in all relevant operating conditions, is essential for NASA, because such research is currently beyond the capabilities of regulators such as the FAA." He further added that *"Certification issues can be show-stoppers if not addressed early in the R&T process."*

Do you agree with Dr. Kaminski's concern and if so, what research will you have to facilitate future certifications, especially for human interactive systems? When will this research begin and when are significant results anticipated?

A9. The FAA believes it either has the appropriate standards in place or has the appropriate R&D and standards-development activities underway to develop the necessary certification standards to support the insertion of NextGen technologies over the next ten years. Examples include electronic flight bags, ADS–B, Data Communications, enhanced flight vision systems, and complex software and digital systems. The FAA works closely with industry advisory groups, such as RTCA and Aviation Rule-making Committees (ARCs), in developing the new standards.

The FAA also continues to explore longer-term advanced NextGen concepts beyond the ten year horizon in partnership with other partner agencies, including NASA. As these concepts mature, the FAA will work with these agencies to transition the technology into use. These transitional activities will include research into the appropriate means to certify technologies that extend beyond the bounds of existing certification standards.

Q10. One of the biggest challenges for the FAA in implementing NextGen will be to not only add or change technologies, but also change the operations of the system.

Q10a. How will you integrate implementation of these technology programs, like ADS–B, and the operations that will take advantage of the improved technology?

A10a. The FAA has developed and maintains an updated NAS Enterprise Architecture which provides the framework and technical strategy for the integration and transition of NextGen capabilities. NextGen capabilities are implemented by applying the principles of System Engineering both to define the requirements for each system and to align implementation schedules across programs.

Q10b. Who in FAA will be responsible for integrating and meeting the schedules for providing these operational capabilities?

A10b. The Sr. Vice President for NextGen and Operations Planning is responsible for the integration and implementation of all NextGen elements, which are executed by program offices and other organizations dispersed throughout the agency. Within NextGen and Operations Planning, the NextGen Integration and Implementation (I&I) Office has been established to develop and manage the FAA NextGen Implementation Plan, and the budget that supports it. Working with the programs and other performing organizations, the I&I Office orchestrates the execution of major portfolios of work and is responsible for the integrated program planning necessary to achieve NextGen capabilities. The I&I Office is working across all service units and programs necessary to make NextGen successful to ensure all the activities needed to realize a capability are aligned, funded, and on track.

Q11. In the House-passed Reauthorization Bill, specific direction was given to FAA to develop a comprehensive plan to safely integrate commercial unmanned aircraft systems into the national airspace system. Has the JPDO made progress in establishing:

Q11a. What research needs to be conducted to address the safe integration of commercial unmanned aircraft systems into the National Airspace System?

A11a. Developing a strategy for the further integration of unmanned aircraft systems into the national airspace system will require extensive research and analysis before any recommendations can be developed.

Q11b. How acceptable standards for operations and certification of commercial unmanned aircraft systems would flow from research?

A11b. The discussion on acceptable standards will require the involvement of the agencies that perceive a need for possible UAS operations in controlled airspace. The JPDO is engaged in multi-agency discussions regarding various collaborative approaches to addressing this issue.

Q12. In the recently completed JPDO comparison of NextGen and its European counterpart SESAR, it was noted that:

> *"Probably the most easily recognized difference in the two concepts is the breadth of scope. The NextGen ConOps includes a full 'curb-to-curb' approach that includes passenger and intermodal security considerations."*

A12. The recently released NextGen Integrated Work Plan (IWP), Version 1.0 includes a range of security operational improvements that directly address the needs of the "curb to curb" concept. The IWP was developed with the direct input of all of the JPDO government and industry partners to include the Department of Homeland Security.

Q12a. What are some examples of R&D tasks in the Integrated Work Plan that address "curb-to-curb" aspects such as security, passenger delay at gates, etc.?

A12a. The key operational improvements that directly address "curb-to-curb" needs include integrated passenger screening, credentialing and identification as well as enhanced and integrated screening and credentialing for airport personnel.

Q12b. What priority is actually being given to those R&D tasks in dollars—or manpower—terms?

A12b. The IWP will continue to evolve to provide DHS, and the airport community, as well as other participating agencies, with important guidance to assist them in developing their priorities, plans and budgets. As for priority, DHS, through the Transportation Security Administration, is currently researching and testing, in an operational environment, various technologies that will improve passenger screening and allow for the integrated flow of data and information in the airport environment. The DHS is allocating $128 million in 2009 for the testing and deployment of new technology for use in screening airline passengers.

Q13. You indicate in your statement that the Integrated Work Plan (IWP) will be "published this month" [i.e., September 2008]. That said, when will the "prioritization of elements" you allude to in your statement be completed?

A13. The JPDO Integrated Work Plan (IWP) published in September 2008 provides initial guidance to NextGen partner agencies on the steps necessary to achieve the NextGen vision. It does not address priorities of activities.

Each NextGen partner is responsible for developing detailed plans for the implementation and execution of the NextGen needs within their respective areas of responsibility and for prioritizing their respective tasks. The JPDO has committed to working closely with each of its partners to facilitate alignment between the

NextGen partner plans and the IWP. FAA's near and mid-term plans have been aligned with the IWP. The FAA's detailed plans are provided in the NextGen Implementation Plan scheduled to be published in January 2009. JPDO will not be able to reflect cross-agency prioritization in its IWP until all agency detailed NextGen plans are final.

Questions submitted by Representative Ralph M. Hall

Q1a. With the upcoming change in Administrations, do you foresee difficulties maintaining program continuity during the transition?

A1a. Civil aviation is a critical engine for economic growth and regardless of the change in Administrations, the inefficiencies of the current ground based air traffic control system result in delays that already cost operators and consumers billions of dollars each year. We believe that the new Administration will proceed with replacing the aging air traffic control infrastructure. The industry needs NextGen to provide operational, environmental, and safety enhancements that deliver benefits to stakeholders today and prepare the way for the future. The Congressionally authorized approach to NextGen utilizes a multi-agency effort to create and carry out an integrated plan for the NextGen system.

Q1b. Does NextGen have enough traction among its partner agencies to maintain momentum in the months ahead?

A1b. There is some concern about remaining under a Continuing Resolution for the entire fiscal year since the FAA would be essentially operating at Fiscal Year 2008 funding levels. The Fiscal Year 2009 President's Budget included a significant increase for NextGen over Fiscal Year 2008 levels. This funding is required to keep NextGen on track with the published Implementation Plan and is necessary to achieve the mid-term capacity and environmental goals integral to the National Airspace System mid-term architecture.

Q2. The Joint Planning and Development Office is a planning and coordinating body that relies on the cooperation of its federal partners to provide the expertise and resources needed to accomplish NextGen.

Q2a. With slightly more than four years of experience, how would you rate the effectiveness of the JPDO, especially with regard to engaging and sustaining the cooperation of the participating federal agencies?

A2a. The interaction has very been promising in many aspects. With the FAA there has been consistent interaction on the Concept, Enterprise Architecture (EA) and Integrated Work Plan (IWP). This effort has included alignment of the FAA's NAS EA with JPDO's NextGen EA and the FAA's NextGen Implementation Plan with JPDO's NextGen IWP. Engagement with NASA has also been very successful. NASA has been very active in supporting the concept and integrated work plan and, with the NASA Airspace Program, mapping its research to the IWP. JPDO has also sponsored the creation of FAA/NASA Research Transition Teams to support the technology transfer of products to the FAA for implementation and the support of the FAA to NASA researchers in areas of operational expertise and system integration.

With the Department of Commerce and Department of Defense there has been very good engagement on the evolution of aviation weather with specific actions identified to improve collaboration on aviation weather products. A new effort with DOC, DOD and the Department of Homeland Security has recently been established to examine Multi-function Phased Array Radar for potential use for weather and surveillance purposes.

With FAA, DOD and DHS the JPDO has had good cooperation on Net-Enabled Operation (NEO) demonstrations, which have been successfully fostered by JPDO. JPDO has also been successful this year in getting DOD commitment to expand its role in NextGen with a large emphasis on enabling net-centric operations, a core requirement for all the member agencies to move NextGen forward.

Q2b. What concerns, if any, do you have about the JPDO's effectiveness following the reorganization?

A2b. Collaboration among the JPDO partner agencies has continued to increase since the reorganization. The reorganization will continue to strengthen the effectiveness of JPDO as the agencies begin to move from planning to implementation. Even in early implementation activities such as NEO or weather or tech transfer from NASA to FAA, there is a shift from activity leader to facilitator on the part of JPDO. With focus on implementation activities growing, the inclusion of JPDO

closer to that action will improve JPDO's ability to facilitate cross-agency cooperation for the near and mid-term while not diminishing its continuing role as long-term definition leader.

Q3. FAA is taking on greater research and development responsibility for NextGen, notably in disciplines that had been conducted by NASA.

A3. The FAA has been evaluating the resources that will be required to support NextGen research and development (R&D) during this past year and the following are the results to date.

Q3a. Where will these new research capabilities be housed?

A3a. The FAA has conducted a gap analysis to assess how existing NAS modeling, simulation, and test facilities support the R&D necessary for design and implementation of NextGen. This analysis has identified shortfalls in existing capabilities, the need for some new simulation capabilities, and opportunities to leverage external ATC, flight deck, and software assurance capabilities. As a result, the FAA is upgrading, co-locating, and integrating existing ATM and CNS simulation capabilities to support NextGen concept validation and integration studies. Also, the FAA, DOD and NASA are participating in a year long examination of the national research and development infrastructure. This study, directed by the Office of Science and Technology Policy, is comparing existing research facilities across the Federal Government to requirements identified in the National Aeronautics Research Plan and will report on both shortfalls and duplications.

Traditionally, the FAA has evaluated concepts and technologies through the use of modeling, simulation (both fast time and real time human in the loop), engineering analysis, field prototypes, and operational demonstrations. For NextGen, we are establishing partnerships with industry, academia, and the airlines to develop three NextGen demonstration capabilities in New York, Texas, and Florida.

Q3b. Will FAA have to build new facilities?

A3b. The FAA continues to maintain our 30+ year relationship with NASA through the FAA Research Field Offices at NASA Langley and NASA Ames Research Centers, with researchers also on-site at NASA Glenn and NASA Kennedy Space Center. Through ongoing Interagency Agreements, FAA can use NASA facilities and personnel to augment our research capabilities. Moreover, the FAA is accelerating transition from research to implementation through Research Transition Teams (RTT) between NASA and FAA, facilitated by the JPDO. The goal of the RTTs is to ensure that R&D needed for NextGen implementation is identified, conducted, and effectively transitioned to the implementing agency

While considerable attention must be given to the research needed to develop NextGen, we must also note that the FAA is maintaining a healthy research program in our core research areas of aircraft safety, airport technology, fire safety, fuels and propulsion, human factors, weather, wake turbulence, atmospheric hazards, airworthiness assurance, and the environment and energy. We maintain a cadre of world class scientists and engineers supported by unique national facilities at the FAA William J. Hughes Technical Center.

Q3c. Does FAA have the scientists, engineers and project managers to carry out the research?

A3c. The FAA is adding scientists, engineers and project managers to its workforce. To ensure that we have aligned the right capabilities, the FAA has enlisted the National Academy of Public Administration to assess the skill sets required to implement NextGen and develop a strategy to obtain this expertise. Internally, staffing needs continue to be assessed corporately and, over the past two years, the NextGen and Operations Planning Office have hired 178 new employees within the technical and programmatic disciplines. Training programs in the areas of project management, system engineering, safety management, human factors, and modeling and simulation are available. In 2004, the ATO Systems Engineering Program was established offering certificates in 1) System Design and Architecture and 2) Supportability and Logistics. To date, 57 graduate certificates have been earned by ATO employees and 60 more employees are currently enrolled in the program.

Additionally, 75 universities augment our internal resources through our congressionally mandated Air Transportation Centers of Excellence (COE) long-term partnerships. The university members and their industrial affiliates conduct research, education and training in the following mission critical focus areas: airport technology, operations research, general aviation, noise and emissions mitigation, advanced materials, and research in the intermodal transportation environment. In addition to providing access to their research facilities throughout the country, more

than 100 world-class faculty and 300 graduate students are currently available and prepared to support ongoing aviation research requirements.

Q4a. Will FAA decommission its network of ground-based radars once NextGen is fully implemented, and if so, how will our government track non-cooperating targets?

A4a. The FAA maintains and uses two types of radars—primary radars which do not require cooperation, they "skin paint," and the radio based secondary radars which do require the aircraft to cooperate. The NextGen implementation of ADS–B is directly related to the cooperative secondary surveillance radars.

While ADS–B will offer considerable benefits in terms of system operations there are additional security and national defense concerns that need to be considered. Both the Department of Homeland Security (DHS) and the Department of Defense (DOD) have expressed the need for continued primary, non-cooperative radar capabilities.

The FAA also recognizes that a back-up system is needed in case of problems with the GPS satellite system In 2006, a team from the FAA, industry, and the military performed an analysis and the agency adopted the recommendation to maintain about half the current network of secondary radars as an ADS–B back-up system.

The table below highlights the plan to reduce the existing 365 Secondary Surveillance Radars (SSRs) used for both terminal and en route surveillance to 190 SSRs (40 terminal and 150 en route).

Radars	Existing Quantity	Backup Quantity (Terminal and En Route)	Decommissioning Schedule
ASR-11 (SSR Only)	66	0	Decommissioned completely over a 7 year period from 2018 - 2024
ATCBI-4/5	32	0	Decommissioned completely over a 7 year period from 2018 - 2024
ATCBI-6	123	123	N/A
Mode-S	144	67*	Decommissioned partially (77 radars) over a 7 year period from 2018 - 2024
Total SSRs	365	190	

*40 Terminal, 27 En Route

Q4b. Who will have principal responsibility to detect and monitor unfriendly aircraft?

A4b. The FAA does not plan to remove any primary radar systems and continues to use primary radar to mitigate single-aircraft avionics failures. Primary radar data remains available to the DOD and DHS to detect and monitor unfriendly aircraft.

The long-term strategy for non-cooperative surveillance requires a multi-agency perspective. As part of its cross-agency role, NextGen's Joint Planning and Development Office (JPDO) has established a joint Interagency Surveillance Study Team (ISST) working with the DOD, the DHS, the Department of Transportation, the Federal Aviation Administration, and the Department of Commerce to address the issue.

The ISST has recommended the establishment of a formal and institutionalized mechanism for the management and ownership (to include funding) of the Nation's integrated surveillance capabilities. Under this approach all future national aviation surveillance information requirements are analyzed holistically. This JPDO led approach will ensure that the needs and responsibilities of the key stakeholders are addressed.

These proposals have been presented to the JPDO's Board of Directors and will shortly be considered by the NextGen Senior Policy Council.

Q4c. To what extent will the introduction of NextGen-related capabilities lead to the closure of other (non-radar) obsolete FAA facilities?

A4c. As we evolve to NextGen, we anticipate that fewer facilities will be needed to operate the National Airspace System in a safe and efficient manner. As the FAA and the aviation community transitions to satellite-based navigation capabilities, the number of ground navigation systems can be significantly reduced with the extent and time-frame for this reduction dependent upon the speed which aircraft owners equip with new avionics. Up to a 50 percent reduction in legacy en route

navigation facilities is considered reasonable in the NextGen time frame. In addition, a significant number of ground-based approach and landing systems in the airport environment (ILS, Terminal VOR's) can eventually be decommissioned and replaced with GPS-enabled capabilities.

Q5. The ADS–B program is fundamental to NextGen. What are the major risks with ADS–B in terms of capabilities, schedule, cost, and industry acceptance?

A5. The FAA has a rigorous risk management process required on every program. As part of that process, the ADS–B program has identified its high risks, developed mitigation plans for those risks, and maintained a status report on the progress of those mitigation activities. These are the high risks:

Industry Acceptance:

Risk Statement: If National Airspace System users demonstrate active opposition to avionics related airspace mandates (ADS–B), there may be delays in required rule-making activities and/or the program may experience a reduction in benefits.

Planned Mitigation: This is a four pronged approach: 1) getting the right implementation and benefits message out (measure this with feedback, user surveys, etc.), 2) quickly move to resolve community issues through accelerated rule-making activities, 3) delivering a legacy transitioning plan, and 4) working with the Air Traffic Management Advisory Committee (ATMAC). The ATMAC provides a forum for user interface.

Status on Mitigation Plans: The Notice of Proposed Rule-making comment period closed in March 2008; An Aviation Rule-making Committee (ARC) was chartered to review benefits of early equipage and to review comments received on the NPRM. The ARC submitted its recommendations on the NPRM comments on September 26, 2008. The FAA is currently drafting plans for responding to the ARC recommendations on early equipage. In addition, the program office has been actively engaged in user community outreach activities, including industry days and user community conferences.

ADS–B broadcasting on 1090 MHz:

Risk Statement: Without proper control of the 1090 MHz spectrum, the addition of SBS (Surveillance and Broadcast Services) to the current environment may reduce the performance of ADS–B and other 1090 MHz systems, reducing benefits and system performance.

Planned Mitigation: To mitigate this risk of spectrum saturation, two parallel approaches are underway: 1) 1090 MHz Spectrum Risk Panel is looking into the technical effectiveness of implementing various proposed solutions to reduce the individual 1090 MHz systems usage of 1090 MHz , and 2) 1090 MHz Spectrum Alternatives Analysis team is to provide a low-risk, cost effective solution to be implemented to reduce the congestion problem.

Status on Mitigation Plans: The Spectrum Risk Panel provided a final report to the FAA program office in August 2008. Additional assessments and recommendations for mitigations are underway. The Alternatives Analysis team defined their objectives and requirements and will develop final alternatives and definitions based on the August Spectrum Risk Panel report.

Displaying ADS–B Data in the current automation platforms and their related displays:

Risk Statement: Currently the automation platform (MEARTS) does not process and display ADS–B data provided by ITT. If MEARTS is not modified to support that data set by April 2010, the Surveillance and Broadcast Services Juneau IOC will be delayed.

Planned Mitigation: Establish an automation requirements work group. Coordinate with computer human interface work group, separation standards work group, and system test and evaluation work group. Conduct alternatives analysis to determine preferred means to integrate the ADS–B data on each automation platform. Develop prototypes and conduct simulations on automation systems, and develop final automation requirements.

Status of Mitigation Plans: The final visual specification for use of multiple surveillance sources in Air Traffic Control has been provided by program office. Agreements on plans to resolve the computer human interface requirements and automation requirement issues have been reached. The program office is currently finalizing an integrated schedule for the automation platform.

Q6. You testified that JPDO's gap analysis identified seven critical areas that require additional focus. For the record please: (1) identify them; (2) designate the

partner agency having primary responsibility; and (3) describe how each of these critical areas will be addressed.

A6. According to the JPDO's analysis there are seven critical areas that require additional focus. The following are the issues involved:

Issue	Lead
NextGen Validation and Business Case	JPDO
Develop an analysis and coordination framework to identify planned analyses and to jointly develop a methodology validation process.	
Air/Ground Functional Allocation	NASA
Develop a decision roadmap to clearly articulate the changes associated with these evolving roles.	
Integrated Surface/Arrival/Departure	FAA
Multi-agency research transition teams are addressing this issue and the associated risk.	
Closely-Spaced Parallel Runways	FAA
Develop an evolution roadmap for the operation of runways as a function of future changes in aircraft spacing.	
Addressing Environmental Constraints	FAA
Develop an analysis capability to create better environmental metrics, assess implications for technology requirements and provide guidance for better investment decision making.	
Security Risk Management	DHS
Develop an integrated security approach to address individual vulnerabilities with a specific focus on risk based metrics.	
Verification and Validation of Complex systems	NASA
Begin with a symposium on this issue and then create a multi-agency roadmap for the development of V&V methodologies to support NextGen.	

Question submitted by Representative Laura Richardson

Q1. What are your thoughts on concerns conveyed April 1–2, 2008 at the National Academies workshop?

A1. The National Academies workshop provided interesting perspectives that highlighted some shortfalls regarding the JPDO, NextGen and the NextGen R&D Plan. There was significant discussion regarding the importance of system level modeling to support NextGen planning, research, and investment. This discussion was particularly timely and validated a JPDO focus in that at the time of the workshop, JPDO was in the process of developing a much more rigorous modeling capability based on its determination of this shortfall.

Another major point was the limited scope of R&D programs that has been reviewed and considered to date. This was a valuable insight. The workshop discussion highlighted the need to look beyond FAA and NASA, and consider other agencies, the private sector (especially the airport community) and international bodies. The JPDO has increased its efforts with respect to each of these sectors and the workshop discussion was helpful in guiding that effort. The newly established multi-agency, DOD led, net-centric initiative is a good example of the JPDO increased scope and leadership.

Finally, there was substantial discussion centered on implementation. While the participants acknowledged that the JPDO is not an implementation entity, they expressed concern that the plans did not provide the community with a clear view of a structured pathway to implementation. The recent FAA reorganization makes this

connection clear with the creation of an integration and implementation entity within the Air Traffic Organization.

Questions submitted by Representative Paul C. Broun

Q1. On October 5, 2007, the FAA issued a proposed rule requiring aircraft in controlled airspace be equipped with ADS–B by 2020.

A1. Background:

An Aviation Rule-making Committee (ARC) was chartered in July 2007 to support the ADS–B rule-making. The ARC's membership covers every sector of the aviation industry, and includes members from the government and academia. The ARC was tasked to:

- Serve as a platform for developing a report in optimizing operational benefits of ADS–B prior to implementing a nationwide ADS–B airspace rule. (This report was delivered in October 2007. The FAA is currently developing plans to address the report.)
- Make specific recommendations to the FAA concerning the NPRM requirements (this report was delivered in September 2008).

Q1a. What is the FAA doing or what is the FAA's plan to encourage voluntary ADS–B equipage? It seems that the FAA is too focused on the equipage mandate, and that a better approach would be to focus on the avionics and incentives to encourage voluntary equipage.

A1a. The FAA is engaging with the community to encourage equipage, and many of the recommendations cited in the ARC's October 2007 report demonstrate that there is a willingness by the airlines to equip early, provided that the FAA creates the environment (infrastructure, routes and procedures) that enables early benefits to airline operations. Specifically, two of the ARC recommendations focus on agreements:

- Recommendation #9: Leverage the benefits of ADS–B information to incentivize equipage by establishing agreements with specific operators.
- Recommendation #10: Continue to establish agreements with local and State governments to leverage the benefits of ADS–B.

Since that initial ARC report, the FAA has held the following meetings to determine incentive mechanisms that might be included in potential agreements:

- January 2008: NetJets, American Airlines, FedEx
- April 2008: Continental Airlines, DayJet, Wisconsin Department of Transportation, Minnesota Department of Transportation
- May 2008: DayJet Follow-up
- June 2008: Follow-up with American Airlines, California Department of Transportation
- July 2008: Additional Follow-up with American Airlines, United Airlines
- October 2008: USAirways

The following table summarizes the feedback from these meetings and shows what may be an incentive to users to equip early.

Category	Application	Outcome	Benefit
Safety	Enhanced Visual Acquisition, and Wx and NAS Status Situational Awareness	Fewer Aircraft to Aircraft Conflicts Fewer Encounters with Hazardous Weather	Minimize Fatalities, Injuries, and Aircraft Damage
	Airport Surface Situational Awareness and Final Approach and Runway Occupancy Awareness	Fewer Runway Incursions and Accidents	Minimize Fatalities, Injuries, and Aircraft Damage
Efficiency / Capacity	Enhanced Visual Acquisition and Visual Approach	Continuation of Visual Approaches in Marginal Conditions More Efficient Spacing during Visual Approaches	Minimize Interarrival Spacing and Maximize Peak Airport Arrival Throughput
	Enhanced Surveillance in Radar Airspace	More Efficient En Route Metering to Arrival Fix (improve TMA performance) More Efficient En Route Conflict Resolution (improve URET performance) Provide Access to Parallel Runways when Not Otherwise Available Provide Access to Performance Routes	Minimize Flight Times from Extended Terminal Area to Runway Minimize Distance and Flight Times associated with Conflict Resolutions Maximize Peak Airport Arrival Throughput and Minimize Delays due to Terminal Congestion Minimize Ground Delay (e.g. East Coast routes)
	Surveillance in Non-Radar Airspace (NRA)	More Efficient Separation on Approach More Efficient Separation En Route	Maximize Peak Airport Arrival Throughput and Minimize Delays due to Terminal Congestion Maximize En Route Sector Throughput
	Distribution of Surface Surveillance to AOCs	Improved Asset Tracking/Resource Scheduling	Prioritize Critical Flights in Taxi Queue, Optimize Personnel Utilization
User Cost Savings	Synergize Capabilities within Avionics	Replace Existing Functions (GA ELT / Transponder)	Reduce Cost of Ownership
	Government Financial Incentives	Shared Costs, Tax Incentives, Grants, Interest Free Loans	Reduce Cost of Ownership

Q2. The ADS–B equipage mandate is extremely costly and provides no benefit to general aviation.

Q2a. The majority of the benefits are in the high-altitude airspace or for aircraft landing at the Nation's 35 OEP airports. So, why is the mandate so broad?

A2a. While it is true that many of the advanced applications of ADS–B In and Out will be of benefit to the high altitude major metro area customers, the initial benefits of ADS–B have and will support the low altitude user group by providing traffic and flight information to ADS–B equipped aircraft. The provision of radar-like services and the increased situational awareness for the pilot have supported aircraft operating in more remote areas and aircraft operating under visual flight rules. Specific low altitude user groups that have and will benefit from ADS–B include operators in Alaska, helicopters, especially in the Gulf of Mexico where a significant number of daily operations take place, and General Aviation aircraft across NAS especially with the related traffic and flight advisory information, and support timely search and rescue.

Q2b. Has the FAA considered limiting the ADS–B equipage mandate to aircraft operating above FL180 or landing at the Nation's 35 OEP airports?

A2b. Background: The ADS–B Aviation Rule-making Committee (ARC) was formed in July 2007 to support the ADS–B rule-making. The ARC's membership covers every facet of the aviation industry, and includes members from the government and academia. The ARC was organized to provide the agency the broadest perspective possible as it advances the ADS–B rule-making. The committee had the following two tasks:

- As an initial tasking before the publication of the Notice of Proposed Rulemaking (NPRM), the ARC should serve as a platform for the development of a report on how operational benefits of ADS–B could be optimized before compliance with a nationwide ADS–B mandate. The report was delivered to the FAA in October 2007.
- Once the NPRM is published and reviewed by the ARC, the ARC should make specific recommendations to the FAA about any changes that should be made to the proposed language in the NPRM. The ARC provided these recommendations to the FAA on September 26, 2008.

The ARC, as a part of its work on its second task, evaluated a phased approach to implementing ADS–B which would have required ADS–B sooner in Class A airspace and at the Nation's 35 OEP airports. The ARC was unable to reach a con-

sensus on this approach and, therefore, recommended that the FAA retain the 2020 compliance date in the original Notice of Proposed Rule-making (NPRM).

To further address the issue of low altitude equipage, the ARC identified additional measures that would benefit the low altitude community and recommended that the FAA take advantage of the opportunity to provide a positive business case for that large segment of the aviation community. Specifically, Recommendation #9 requests:

> *The FAA should implement the necessary incentives to create a positive business case for low altitude airspace users. This requires the FAA to make changes that result in lower investment costs and increased benefits, and provide economic incentives to offset costs when benefits are insufficient for a particular operator segment. If the ADS–B mandate results in the low altitude segment of the aviation community investing more into the system than the benefits enabled, the FAA should not mandate ADS–B Out for that segment of the community.*

In addition, Recommendation #18 suggests:

> *The ARC, based upon analysis it has performed, urges the FAA to allow non-diversity antenna installations for visual flight rules (VFR) aircraft flying through high-density airspace, for example class B and C and below 15,000 feet (1090) or below FL 180 (UAT) but not landing at the primary airports. Additionally, the FAA should continue to resolve the barriers (as identified by the ARC) to permit single-antenna installations on low altitude, slow moving aircraft. The ARC recommends that the FAA conduct the necessary testing to identify appropriate solutions.*

The Surveillance and Broadcast Services program office is currently evaluating these recommendations from the ARC and will determine how to proceed for the final rule on ADS–B equipage.

Q3. The DOT Inspector General, GAO and others have testified that stakeholder acceptance is going to be key to a successful ATC modernization and transition to a satellite-based system.

A3. The ADS–B Aviation Rule-making Committee (ARC) was formed in July 2007 to support the ADS–B rule-making. The ARC's membership covers every facet of the aviation industry, and includes members from the government and academia.[1] The ARC was organized to provide the agency the broadest perspective possible as it advances the ADS–B rule-making.

Q3a. While the entire aviation industry supports modernization, as far as I can tell, the FAA's strategy and implementation plan has little (possibly no) support from stakeholders.

A3a. In the September 26, 2008 report, the ARC emphasized its support for ADS–B Out implementation by 2020.

Q3b. How is the FAA handling the comments submitted from aviation stakeholders?

A3b. The ARC reviewed 1,423 comments on the Notice of Proposed Rule-making (NPRM) submitted to the docket by 165 entities, categorized the comments for further analysis, and studied the issues underlying 1,101 of the 1,423 comments. The ARC was tasked with resolving these comments and making a final recommendation to the FAA, which was provided on September 26, 2008. The committee focused on the link implementation strategy, programmatic issues, performance requirements and an avionics transition plan. The ARC made 36 summary recommendations regarding the ADS–B link strategy, program, business case, required equipment, security, and privacy.

The Surveillance and Broadcast Services (SBS) program office is reviewing this report and will determine how to proceed with the recommendations prior to finalizing the rule. In addition, the SBS program office is reviewing the remaining 322 comments not addressed in the ARC submittal. These comments focus on general

[1] The ARC had participation from the following stakeholder organizations: Joint Planning and Development Office (JPDO), Air Transport Association (ATA), Aircraft Owners and Pilots Association (AOPA), Airbus, Air Line Pilots Association, Alaska Airlines (ALPA), Aviation Communication and Surveillance Systems (ACSS), Boeing, Cessna, Department of Defense, Federal Express, Garmin, General Aviation Manufacturers Association (GAMA), International Air Transport Association (IATA), Massachusetts Institute of Technology (MIT), MITRE/CAASD, National Air Traffic Controllers Association (NATCA), National Business Aviation Association (NBAA), Regional Airline Association (RAA), Rockwell Collins, Southwest Airlines, United Airlines and UPS.

opposition, editorial comments, safety, extension of the comment period, impact to small businesses, regulatory evaluation edits, testing and maintenance, and military/DOD comments.

The FAA's Rule-making Council is tentatively planning to approve the Phase 3 Rule-making Project Record (RPR) in January 2009.

Q3c. Does the FAA intend to issue a supplemental notice of proposed rule-making or does the FAA intend to proceed forward with a final rule?

A3c. At this time, the FAA does not intend to issue a Supplemental Notice of Proposed Rule-making (SNPRM). The FAA is proceeding with the development of a final rule which will be issued in April 2010.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Gerald L. Dillingham, Director, Physical Infrastructure Issues, Government Accountability Office

Questions submitted by Chairman Bart Gordon

Q1. Some observers have commented that the degree of participation by the partner agencies seems to run on a continuum from a significant amount of participation to seemingly not very much at all. The Federal Aviation Administration (FAA) and National Aeronautics and Space Administration (NASA) are consistently indicated as the most involved participants.

Q1a. In your opinion, to what extent are the partner agencies participating in the vision and work of the Next Generation Air Transportation System (NextGen)?

A1a. The partner agencies' participation in the vision and work of NextGen has varied to date and will continue to evolve over time. Interagency partnerships mature slowly because it takes time to forge working relationships and establish accountability. While FAA and NASA have been the most involved in the planning and coordination of NextGen, the other agencies are also participating. The Department of Defense, for example, is transferring to NextGen the technology it has developed for sharing information across networks, establishing a program office to coordinate all of its NextGen activities, and collaborating with FAA and the Department of Commerce to develop and implement NextGen's weather forecasting capability.

Furthermore, the Joint Planning and Development Office (JPDO), which was created to plan for and coordinate the NextGen activities of federal and non-federal stakeholders, has established some practices that are important to institutionalizing a collaborative process. For example, a memorandum of understanding, signed by the Secretary or another high-ranking official from each partner agency, defines the partner agencies' roles and responsibilities. In addition, some NextGen goals and activities have been incorporated in partner agencies' key planning documents such as FAA's NextGen Implementation Plan, and JPDO and the Office of Management and Budget (OMB) have developed a process for identifying NextGen-related research programs in the partner agencies' budgets.

Q1b. How could the role of the partner agencies be changed to enhance their participation or positively affect the development of NextGen?

A1b. We believe that the partner agencies' participation in NextGen could be enhanced by further incorporating NextGen goals and activities in the agencies' key planning documents and research agendas. For example, FAA has refocused one of its key planning documents—the Operational Evolution Partnership—making it into the NextGen Implementation Plan. Formerly a plan for enhancing airport capacity, the NextGen Implementation Plan has been expanded and revamped to become a comprehensive description of how FAA will implement NextGen. We believe that similar efforts by the other partner agencies could increase their participation in NextGen.

Q2. In your opinion, how successful has JPDO been in developing conceptual and technical descriptions of what NextGen will consist of? How about in developing a plan for the coordinated implementation of a transformed future system?

A2. JPDO has made progress in developing planning documents that provide conceptual and technical descriptions of NextGen. However, further iterations of these documents will be needed as NextGen technologies are developed. JPDO's authorizing legislation requires the office to create a research and development (R&D) plan for the transition to NextGen. This requirement led JPDO to develop initial versions of the Concept of Operations, Enterprise Architecture, and Integrated Work Plan (IWP). The Concept of Operations is the fundamental planning document from which the other two documents flow. Version 2 of the Concept of Operations, issued in June 2007, describes how the NextGen system is envisioned to operate in 2025. Version 2 of the Enterprise Architecture, issued in July 2007, is a technical description of the NextGen system, akin to blueprints for a building. The Enterprise Architecture provides a means for coordinating among the partner agencies and private-sector manufacturers, aligning relevant R&D activities, and integrating equipment. IWP, the most recent version of which was issued in September 2008, is JPDO's plan for achieving NextGen. It describes the integrated framework needed to transition to NextGen and will continually need to be refined and enhanced to reflect current priorities, budgets, and programs.

Our work indicated that the previous version of IWP lacked critical information and was not sufficiently "user friendly" to be used effectively as a plan for coordinating the partner agencies' implementation of NextGen. Our review of the most recent version of the plan indicates that it is more detailed, contains further research plans, and shows interrelationships among activities that should be useful for coordinating those activities. This version of IWP is an automated, searchable, user-friendly database—that we found will have the capability to track dates and identify programs that are behind schedule, making it useful, but not sufficient, for oversight. According to senior JPDO officials, this version identifies the specific operational improvements and capabilities that NextGen will incorporate and shows what policies, research, and other activities are needed to enable those improvements and capabilities; when they are needed; and what entities are responsible for them. Moreover, this version includes schedule information that has been updated to reflect newly available information, coordination with FAA schedules and plans, and public comments received on the previous version, according to JPDO and FAA officials. This version also identifies the sequence of research activities that the partner agencies must complete before specific NextGen capabilities can be implemented. The plan should serve as a useful tool in prioritizing and tracking NextGen research.

Furthermore, subsequent versions of IWP are expected to include cost information that decision-makers can use to help understand the rationale for budget requests, monitor costs, and improve future cost estimates for acquisitions. This information will be helpful to decision-makers when budget constraints do not allow all system acquisitions to be fully funded at planned and approved levels and they must decide which programs to fund and which to cut or delay according to their priorities.

In addition, coordination is enhanced by JPDO's efforts to work with OMB to develop a process that allows OMB to identify NextGen-related research and acquisition projects across the partner agencies and consider NextGen as a unified, cross-agency program. Under this process, JPDO and its partner agencies jointly present OMB with business cases for the partner agencies' NextGen-related efforts, and these business cases are used as inputs to funding decisions for NextGen research and acquisitions across the agencies.

Q3. In the transformed NextGen, I understand that roles and responsibilities of key players will change dramatically. Pilots will take on more separation responsibilities and automation will enable air traffic controllers to manage larger numbers of aircraft while improving safety.

Q3a. What are the key aspects from human factors research that FAA and NASA need to get right before we can have confidence that this delegation of decision-making duties is both feasible and safe?

A3a. Our work indicates that the key aspect from human factors research that FAA and NASA must address is how changes in the roles and responsibilities of both air traffic controllers and pilots will affect the safety and efficiency of the national airspace system. According to an FAA official, verbal communication is an example of a human factors area that requires further R&D. Currently, air traffic controllers primarily rely on verbal communication to direct aircraft. Because NextGen will rely more on automated communications, controllers will require training in both understanding and operating in an automated communications environment. The research to support such training has not been conducted, according to FAA.

Q3b. Are the needed R&D programs in place and adequately funded to get that research done?

A3b. While not all of the needed human factors R&D programs are currently in place, FAA plans to increase its investment in human factors research from fiscal year 2009 through fiscal year 2013. Over that period, FAA's human factors research would total $180.4 million. In contrast, NASA started to reduce the size of its human factors research staff in fiscal year 2005, reassigning some staff to other programs and reducing the contractor and academic technical support for human factors research. However, according to NASA, human factors research continues to be a critical component of its aeronautics research program, with activity focused at the foundational level. It remains to be seen if FAA's planned R&D in this area will offset NASA's reductions, since FAA's research is typically at a more applied level.

Q4. In describing FAA's Continuous Lower Energy, Emissions, and Noise (CLEEN) environmental R&D program, your statement indicates that FAA and the JPDO recognize the need to "fill any gaps that may exist between basic research and the transfer to industry for further development." But you also conclude that "the research might prove more difficult and take longer than planned."

Q4a. Can you elaborate on why this might be more difficult and time-consuming than envisioned and how FAA can minimize this problem?

A4a. Filling gaps that may exist between conducting basic research and transferring technologies and tools to industry may be more difficult and time consuming than envisioned for several reasons. CLEEN illustrates this challenge. The House reauthorization bill for FAA is seeking funding for CLEEN.[1] CLEEN would establish a research consortium of government, industry, and academic participants that would allow for the maturation of aviation noise technologies via demonstration projects for further refinement by the aviation industry and eventual incorporation into new aircraft designs. The CLEEN program would support the development, maturation, and certification of engine and airframe technologies for aircraft over the next 10 years to reduce aviation noise and emissions. While acknowledging that CLEEN would help bridge the gap between NASA's R&D and manufacturers' eventual incorporation of technologies into aircraft designs, aeronautics industry representatives and experts we consulted said that the program's funding levels may not be sufficient to attain the goals specified in the proposal. According to these experts, the proposed funding levels would allow for the further development of one or possibly two projects. Moreover, in one expert's view, the funding for these projects may be sufficient only to develop the technology to the level that achieves an emissions-reduction goal in testing, not to the level required for the technology to be incorporated into a new engine design. According to FAA and some experts we consulted, however, the CLEEN program amounts to a pilot project, and if it results in the development of emissions-reduction technologies that can be introduced into aircraft in the near future, it could lead to additional funding from the government or industry for such efforts.

Filling R&D gaps may also be more difficult and time-consuming than envisioned because of uncertainties about the ability of aircraft engine and aircraft manufacturers to incorporate new noise reduction technologies into new engine and aircraft designs. NASA officials stressed that when NASA's research ends, it will be up to engine and aircraft manufacturers to take the next steps to integrate the noise reduction technologies into engine and aircraft designs, and the manufacturers' willingness to do so is not guaranteed. An expert we consulted noted that if manufacturers do take the steps to integrate noise reduction technologies into new designs, the pace of noise reduction will also depend on the pace of development for new aircraft and aircraft engine designs.

Moreover, technical challenges may further complicate efforts to close the gap between agencies' research and manufacturers' development of technologies for incorporation into products. In particular, it may be technically challenging to design aircraft with reduced noise while, at the same time, achieving significant reductions in greenhouse gases and other emissions that will be required to address global warming and improve air quality. Although it is possible to design engines that produce less noise and fewer greenhouse gas emissions, the reductions in greenhouse gases could be limited in engines that produce substantially less noise. Furthermore, engines that produce less noise typically burn more fuel and are therefore more costly to operate. As a result, air carriers may not be inclined to buy jets with engines that reduce noise but may be more expensive to operate.

Q4b. Should NASA be playing a bigger role in this area, as it did in its previous innovative aircraft engine technology development programs?

A4b. It would be useful for NASA to conduct the type of intermediate R&D and demonstration projects that NASA previously conducted and that will be needed for the NextGen program. NASA, however, is now focusing on longer-term fundamental research on noise and emissions and its current aeronautics research budget is about half of what it was in the mid-1990s. Moreover, the budget request for aeronautics R&D for fiscal year 2009 is $447 million, or about 25 percent less than the $594 million provided in fiscal year 2007. Nonetheless, according to NASA, about $280 million of the proposed $447 million would contribute to NextGen. In addition, according to NASA officials, a significant portion of the funding for subsonic fixed-wing aircraft is directed toward emissions-related research, and many other research efforts contribute directly or indirectly to potential emissions-reduction technologies.

Q5. In your February report to the Subcommittee, you indicated that noise reduction technologies may be limited by concerns about global warming as advances in these technologies could make it more difficult to also achieve reductions in

[1] H.R. 2881, 110th Cong. § 505 (2007).

emissions of greenhouse gases. Is GAO saying that reductions in noise and emissions are mutually exclusive or could high fuel prices spur technological innovations we have yet to envision?

A5. I do not think that efforts to achieve reductions in noise and emissions are mutually exclusive, but finding the right balance between them does pose a significant challenge for the partner agencies and private stakeholders. It is technologically challenging to design aircraft that can reduce one environmental concern without increasing another. Since the aviation industry must consider economic as well as environmental concerns, research must consider the trade-offs between noise reduction, emissions reduction, and fuel economy. Engine technology has been relatively successful in increasing fuel efficiency, reducing most types of emissions, and lowering noise, but has not been able to achieve comparable reductions in nitrogen oxide (NO_X), which is a primary source of local air pollution. NO_X has increased because new engines operate at higher temperatures, producing more power with less fuel and lower carbon dioxide and carbon monoxide emissions, but also producing higher NO_X levels, especially at takeoff and landing when engine power settings are at their highest.

Q6. The JPDO was established to plan and coordinate the R&D for NextGen. You testified that the three key planning documents have been developed and that JPDO has been pretty much absorbed into the Air Traffic Organization (ATO). How long do you think the JPDO ought to continue to exist and what would it do?

A6. JPDO was established to plan and coordinate the development of NextGen and should exist for the duration of those tasks. JPDO has developed the key planning documents for NextGen, but further iterations of these documents will be needed as NextGen technologies are developed and implemented. For example, JPDO officials expect to issue annual revisions to the IWP. JPDO also has a central role in coordinating and facilitating the NextGen activities of the partner agencies. For example, JPDO serves as the principal point of contact with OMB in coordinating the multi-agency budgets for NextGen, and its working groups facilitate coordination with industry stakeholders. If JPDO ceased to exist, another entity would have to assume responsibility for these planning and coordinating activities.

JPDO's role could evolve to include additional coordination and oversight activities. For example, JPDO could establish a program oversight capacity that would enable it to perform such functions as (1) coordinating the R&D, systems-engineering, and integration activities of the partner agencies and industry; (2) overseeing multi-agency projects; (3) overseeing, with FAA, the selection of products or outcomes of R&D that would be moved to the next stage of a demonstration project through the Joint Resources Council (JRC);[2] (4) overseeing the fundamental research activities that support the long-term strategic investments of NextGen by managing a portfolio of research conducted by NASA, academia, federally funded R&D centers, and industry; and (5) maintaining a modeling and simulation capability for testing and evaluating alternative NextGen concepts that provide input to such oversight.

Questions submitted by Representative Ralph M. Hall

Q1. With the upcoming change in Administrations, do you foresee difficulties maintaining program continuity during the transition? Does NextGen have enough traction among its partner agencies to maintain momentum in the months ahead?

A1. There is a risk that the upcoming change in Administration will contribute to difficulties in maintaining continuity for NextGen. As FAA begins to implement new systems and transition to NextGen, it is possible that other demands of a new Administration will compete for the attention of FAA's senior leadership. Moreover, FAA, which currently has an Acting Administrator, and its partner agencies face the loss of today's leaders as the new Administration makes its own appointments. Although FAA has implemented many of the financial, management, and acquisition improvements in recent years that will be needed for the transition to NextGen, FAA's new leaders will need to sustain this commitment to provide a firm foundation for continuing to implement NextGen.

[2] FAA's Joint Resources Council establishes and manages acquisition program baselines which define cost, schedule, performance, and benefit parameters for programs over their full life cycle.

It remains to be seen whether NextGen has enough traction with JPDO, FAA, and the other partner agencies to maintain momentum in the coming months. JPDO, however, has established some practices that are important to institutionalizing collaboration among the partner agencies. For example, a memorandum of understanding, signed by the Secretary or another high-ranking official from each partner agency, defines the partner agencies' roles and responsibilities. In addition, some NextGen goals and activities have been incorporated in the agencies' key planning documents such as FAA's NextGen Implementation Plan, and JPDO and OMB have developed a process for identifying NextGen-related research projects in the partner agencies' budgets. Nonetheless, this is a complex multifaceted, multi-decade project and the partner agencies' participation in NextGen can be expected to evolve and vary over time as its requirements change and agencies' mission priorities change.

Q2. JPDO is a planning and coordinating body that relies on the cooperation of its federal partners to provide the expertise and resources needed to accomplish NextGen. With slightly more than four years of experience, how would you rate the effectiveness of the JPDO, especially with regard to engaging and sustaining the cooperation of the participating federal agencies? What concerns, if any, do you have about JPDO's effectiveness following the reorganization?

A2. JPDO has made progress in obtaining the cooperation of participating federal agencies, but the extent of participation has varied. Interagency partnerships mature slowly because it takes time to forge working relationships and establish accountability. While FAA and NASA have been the most involved in the planning and coordination of NextGen, the other agencies are also participating. The Department of Defense, for example, is transferring to NextGen the technology it has developed for sharing information across networks, establishing an office to coordinate its NextGen activities, and collaborating with FAA and the Department of Commerce to develop and implement NextGen's weather forecasting capability. The Department of Homeland Security is participating by contributing "in-kind" services in the form of personnel and research. Furthermore, JPDO has been successful in helping to establish mechanisms to sustain cooperation among the participating federal agencies. In June 2008, a memorandum of understanding was signed by the Secretary or another high-ranking official from each partner agency, defining each agency's role and responsibilities. In addition, as part of the annual budget request, JPDO prepares an Exhibit 300 form for NextGen, which allows JPDO to present OMB with a joint business case for the partner agencies' NextGen-related efforts.[3] This business case is used as input to funding decisions for NextGen research and acquisitions across the agencies.

Since ATO was reorganized in May 2008, JPDO has been housed within the new NextGen and Operations Planning Office and the JPDO Director reports through the Senior Vice President for NextGen and Operations Planning to ATO's Chief Operating Officer. Previously, the JPDO Director reported directly to both the Chief Operating Officer and the FAA Administrator. Now that JPDO is no longer a separate, independent office within FAA and its head no longer reports directly to the FAA Administrator, its organizational position within FAA has declined. This reorganization does not address the concerns of some industry stakeholders that JPDO's reporting status might keep it from interacting on an equal footing with ATO and the other partner federal agencies. In 2007, we reported that it was important for JPDO to have some independence from ATO to counter the perception that it was a proxy for ATO and, as such, not able to act as an "honest broker" between ATO and the partner federal agencies. We pointed out that, to address this issue, the JPDO Director could report directly to the FAA Administrator.[4] Nonetheless, we believe it is too early to tell whether the reorganization has diminished the effectiveness of JPDO, especially in terms of its ability to sustain the cooperation of the partner federal agencies, or if the new governance structure will be acceptable in practice and address the concerns that have been raised. Ultimately, the effectiveness of JPDO will have to be measured by the efforts of the partner agencies to implement policies and procedures, conduct research, and acquire systems that support NextGen.

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[3] Section 300 of OMB Circular No. A–11, Preparation, Submission, and Execution of the Budget (Nov. 2, 2005), sets forth requirements for federal agencies for planning, budgeting, acquiring, and managing information technology capital assets.

[4] GAO, *Responses to Questions for the Record; Hearing on the Future of Air Traffic Control Modernization,* GAO–07–928R (Washington, D.C.: May 30, 2007).

Q3. The Automatic Dependent Surveillance–Broadcast (ADS–B) program is fundamental to NextGen. What are the major risks with ADS–B in terms of capabilities, schedule, cost, and industry acceptance?

A3. ADS–B is a satellite-based aircraft navigation system that allows aircraft to broadcast their position to air traffic controllers, other aircraft, and ground systems. FAA plans to implement ADS–B over the next 15 to 20 years as a key NextGen system. FAA awarded a contract worth up to $1.8 billion for acquiring the ground infrastructure for ADS–B in August 2007 and is developing an ADS–B rule-making, scheduled for issuance in 2010. FAA's initial deployment plans focus on areas of the Nation that do not have radar surveillance, such as Alaska and the Gulf of Mexico, and individual airlines, such as United Parcel Service, which is installing ADS–B on all of its Boeing 757 and 767 aircraft.

Several risks are associated with implementing ADS–B including the cost to industry to equip, incomplete specifications for ADS–B capabilities, and broadcast frequency congestion concerns. Full use of ADS–B depends not only on government efforts, but also involves decisions by the aviation industry about what equipment to purchase and when to purchase it. With ADS–B, for example, an official of RTCA's[5] 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 the aviation industry. The official said that equipping existing aircraft to communicate with the ground stations may not be cost prohibitive for regional and large commercial airlines, but further equipping these aircraft so they can use ADS–B's full capabilities could require cost-prohibitive modifications. Consequently, the official noted that carriers plan to install equipment to use 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. In addition, the official believed that some air carriers were hesitant to equip with ADS–B because of concerns that FAA might not follow through with the deployment of full ADS–B capabilities. We have reported[6] that a demonstration of NextGen capabilities, such as ADS–B, and of efficiencies resulting from their use would give airlines an incentive to equip their aircraft with NextGen technologies. They could then lower their costs by reducing their fuel consumption and decrease the impact of their operations on the environment. Our research indicates that by establishing benefits early in a program's development, demonstrations can increase stakeholders' confidence in an initiative. A demonstration of ADS–B could provide incentives for the aviation community to equip aircraft with compatible technology.

In addition, concerns have been raised about broadcast frequency congestion related to ADS–B. FAA plans to establish two data links for the system. Commercial aircraft and other aircraft operating at high altitudes would send their position to ground stations by transmitting on 1090 MHz while general aviation would use Universal Access Transceivers operating on 978 MHz. On September 26, 2008, FAA's ADS–B Aviation Rule-making Committee called for an urgent study of congestion on 1090 MHz, indicating the frequency is becoming crowded in some airspace with high-density air traffic.

Question submitted by Representative Laura Richardson

Q1. In your testimony you referenced closing and consolidating systems, what do you mean?

A1. To fully realize NextGen's capabilities, FAA will have to reconfigure its air traffic control (ATC) facilities to make them compatible with new technologies and procedures. According to a senior ATO official, the agency plans to report on the cost implications of reconfiguring its facilities in 2009. However, FAA has no comprehensive plan for reconfiguring its facilities. Until the cost analysis is completed and a reconfiguration plan has been developed, the configurations needed for NextGen cannot be implemented and potential savings that could help offset the cost of NextGen will not be realized. Some FAA officials have said that implementing plans for facility maintenance and construction that are based on the current ATC system and do not incorporate the configurations needed for NextGen could, without recon-

[5] RTCA is a private, not-for-profit corporation that develops consensus-based performance standards for air traffic control (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.

[6] GAO–08–1078.

figuration, significantly increase the cost of NextGen. Additionally, some of the capacity and efficiency enhancements expected from the implementation of NextGen may be curtailed if the system's infrastructure needs are not fully addressed.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Calvin L. Scovel III, Inspector General, U.S. Department of Transportation

Questions submitted by Chairman Bart Gordon

Q1. In your statement, you recount FAA's difficulties in implementing the Standard Terminal Automation Replacement System (STARS) program. You say that the original program for 172 sites costing $940 million became one for just 50 sites costing $1.46 billion. So let's look at the math. We reduce the number of sites by two-thirds and pay 50 percent more. Why should such a performance by FAA give the Congress any confidence that NextGen won't suffer the same cost problems?

A1. FAA modernization projects, including STARS, have a long history of cost growth, schedule slips, and performance shortfalls. These problems have translated into reduced benefits to FAA and airspace users, reliance on costly interim systems, and loss of confidence in FAA's ability to manage large-scale acquisitions. As we have noted in reports and testimonies, it will be important for FAA to avoid these problems in developing various NextGen efforts.

The development and implementation of NextGen is a high-risk effort that will require sustained oversight. It will be a top management challenge for the next Administration. To help reduce risk with NextGen, we have made several recommendations to FAA, including the following:

- Reporting NextGen costs to Congress and stakeholders along three vectors, which include developmental efforts, adjustments to existing projects, and NextGen implementation.
- Determining what skill sets and expertise with respect to software development, contract oversight, and systems integration that will be needed to manage NextGen.
- Funding targeted human factors research to ensure that the changes envisioned for pilots and controllers can be safely accommodated.
- Developing and reporting on a new set of metrics for measuring progress with NextGen initiatives that focus on the delivery of a new capability with respect to enhancing capacity, boosting productivity, or reducing Agency operating costs.
- Developing an interim architecture for the 2015 timeframe to help bridge the gap between current systems and NextGen.

FAA has concurred with these recommendations and is taking action. We will continue to monitor FAA's efforts in these areas.

Q2. How successful has the JPDO been developing conceptual and technical descriptions of what NextGen will consist of? How about in developing a plan for the coordinated implementation of a transformed future system?

A2. The JPDO has been successful in developing conceptual and technical descriptions of NextGen. These are outlined in the NextGen Concept of Operations and Integrated Work Plan. JPDO plans call for a system that relies heavily on satellite-based systems, data link communications for pilots and controllers, new automation systems, and robust and secure information sharing. However, planning documents remain at a very high level and are unconstrained and not mature enough to translate into specific requirements for new automation or data link communication systems.

The JPDO has not been successful thus far in developing a coordinated implementation plan for NextGen. FAA and the JPDO have much work to do to develop a realistic transition plan for Congress and airspace users. This is important because NextGen will require airspace users to purchase and install a wide range of avionics at an estimated cost of $15 billion. This is why we believe FAA needs to assess "implementation bandwidth" to determine what reasonably can be accomplished with respect to equipage as well as controller and pilot training in given timeframes.

Q3. Your statement characterizes the JPDO foundational documents such as the Enterprise Architecture as not yet mature enough to drive investment decisions or generate requirements for major NextGen acquisitions. You said that JPDO officials told your office that it will take a year or more for the documents to be effective tools for driving agency budgets, setting priorities, and managing research efforts.

a. In your opinion, is JPDO's response reasonable?

b. Should we expect these foundational documents to take time to mature as advocated by the JPDO?

c. Does this further complicate the research that needs to be done?

A3. As we noted in our statement, some progress has been made with key NextGen foundational documents, such as the NextGen Enterprise Architecture and Integrated Work Plan. However, they remain at a high level and, as FAA points out, are unconstrained with respect to cost. As was noted by the National Research Council, these efforts reflect a lack of top-level system engineering and clearly established priorities. We agree with the National Research Council's assessment.

FAA's statements that it will take a year or more for the planning documents to mature enough to drive investment decision, set priorities, and manage research appear reasonable. It is an unfortunate but accurate assessment of progress to date. We recognize that many stakeholders are frustrated by a lack of progress with the NextGen Enterprise Architecture and overall efforts to move forward with NextGen. Therefore, we believe that FAA should take steps to accelerate these efforts where possible.

We note that it is reasonable to expect these documents to take time to mature and be modified as NextGen concepts and requirements are more clearly defined. Further, these documents will have to be adjusted to reflect the results of ongoing research projects.

Without question, the lack of maturity of the NextGen Enterprise Architecture and Integrated Work Plan complicate the execution of research needed for NextGen. We think FAA and the JPDO need to establish research priorities to help decision-makers understand which investments need to be made first from the wide range of operational improvements discussed in planning documents. As noted in our statement, FAA should provide this Committee with a clear understanding of how it will prioritize research and development, address various research gaps, and update priorities when research results become available or when national priorities change.

Q4. Your office recommended earlier this year that FAA develop an interim architecture or "waypoint" that is manageable and executable for what is expected in 2015. The OIG report says that FAA concurred with this recommendation. Please describe the key attributes that would make this interim architecture both manageable and executable.

A4. We recommended that FAA develop an interim architecture in the 2015 timeframe to reduce risk and help bridge the gap between the current system and the vastly different NextGen. This interim architecture should have a number of attributes to help make it manageable and executable.

First, the interim architecture should clearly define the expected benefits for stakeholders and FAA. Currently, FAA does not articulate the expected benefits of NextGen investments in planning or budget documents. The benefits should focus on enhancing capacity and reducing delays and operating costs.

Second, the interim architecture should show a clear path for how existing systems will transition to NextGen and identify what adjustments will be needed. This is important because over 30 existing systems form platforms for NextGen. Thus, the pace of NextGen will be dictated by progress with existing systems. An integrated approach to software development and integration will be essential to reduce the potential for cost growth, schedule delays, and shifting requirements.

Third, the interim architecture should highlight and publish the timeframes for making the procedural changes needed to get the expected benefits from new systems or a combination of systems. For example, FAA will need to make sure that new procedures that rely on data link communications for controllers and pilots, new routes that rely on on-board aircraft avionics, and new automation capabilities for boosting capacity are in place at specific locations.

Q5. What is the impact of FAA's reorganization on the NextGen development and implementation effort? Can you elaborate on what you characterize in your statement as "friction" between the ATO and JPDO?

A5. As stated in our testimony, it is too soon to evaluate FAA's recent reorganization on NextGen development and implementation. While FAA believes the change will help with implementation, it gives the appearance that the JPDO has been significantly reduced in stature and importance. We do have some concerns that could impact NextGen implementation.

- First, the roles and responsibilities of the JPDO and ATO are not clearly defined. According to FAA, the JPDO will focus on long-term planning and interagency cooperation while the ATO's new NextGen Implementation office will concentrate on short-term efforts. However, it will be difficult to establish clear demarcation lines because implementing NextGen capabilities depend heavily on modifying existing modernization projects. In addition, both offices will have considerable modeling and simulation capabilities for assessing NextGen initiatives.
- Second, while the Senior Vice President for NextGen will be responsible for managing NextGen demonstration projects, major efforts for essential NextGen platforms, such as ERAM and Terminal Modernization, will continue to be managed by other ATO vice presidents. We also note that airports—which play a key role in NextGen—are managed by an FAA office outside of the ATO. Thus, budgetary authority for FAA modernization efforts remains fragmented.
- Third, the new structure will be challenged to deal with complex, cross-cutting agency issues that will need to be resolved. For example, we think it will be difficult for an office within the ATO to work out agreements with DOD, DHS, or NOAA on major decisions affecting surveillance, airspace security, and weather systems.

Further, there has been—and continues to be—friction between the ATO and JPDO that is due in part to vastly different planning horizons. The ATO is an organization that operates the National Airspace System 24 hours a day, seven days a week. The ATO does this very well but it has a short planning horizon. The JPDO, on the other hand, is focused on introducing cutting-edge technologies and transforming the National Airspace System by the 2025 timeframe. It will be important to reconcile these differences to successfully implement NextGen.

Q6. You indicated in your statement that FAA needs to focus attention on airport issues and how NextGen technologies can unlock already congested airports. Can you elaborate on how FAA would do that and how it differs from that already accomplished in it's planning documents?

A6. A top priority for NextGen should focus on enhancing capacity at already congested metropolitan areas, such as the New York airports. An important metric for NextGen is to what extent efforts can increase airport arrival rates under various weather conditions.

Currently, FAA planning documents and budget requests do not detail how individual NextGen efforts can specifically increase airport arrival rates and thereby boost capacity. It would help decision-makers and stakeholders if FAA would show how individual NextGen efforts; like Automatic Dependent Surveillance–Broadcast, data link communications for controllers and pilots, and new ground automation systems; can boost airport capacity. This information will help target solutions to specific airports, set expectations, and help shape consensus among stakeholders about how to move forward with NextGen.

Q7. In response to a question from Ranking Member Hall on OMB's coordination and alignment of research budgets among participating federal agencies, you noted the "great" difference between the budget request submitted by the Department of Commerce for NOAA on weather capabilities and what FAA had expected. What was the magnitude of the difference and what was the basis for FAA's expectation?

A7. The Department of Commerce has the lead role in developing the 4–D Weather Cube, which is expected to provide a single authoritative source for weather observations and analysis. This tool is also expected to provide a common picture of weather for all airspace users. However, there are significant differences between FAA and NOAA regarding how new weather systems will be used.

An internal JPDO assessment found that there is disagreement on synchronizing weather observations, forecasts, and dissemination efforts. This threatens current plans to implement the 4–D Weather Cube in the 2013 timeframe. The assessment also noted that several policy and funding issues need to be addressed; specifically, most of the Department of Commerce efforts that the JPDO expects to rely on are not funded.

Development for the 4–D Weather Cube is estimated to cost more than $300 million and implementation costs, though uncertain, have been estimated at three times as much as to develop the cube. It is difficult to assess FAA's expectations because the Agency has not finalized NextGen weather-related requirements. FAA and Commerce are working to resolve issues and reach some level of agreement in

time for the FY 2010 budget submission. The development of the 4D Weather Cube, funding levels, and the evolution of requirements will require sustained oversight.

Q8. In your statement, you note FAA's difficulties with its ADS–B Notice of Proposed Rule-making and call on FAA to "develop a realistic plan for implementing ADS–B and realizing the air-to-air benefits of the technology."

a. What are the components of a realistic plan?

b. Do the air-to-air benefits you have in mind require both ADS–B "out" and "in" capabilities?

A8. A top priority for the next Administration will be developing a realistic plan for implementing ADS–B. Currently, there is no consensus regarding how to move forward with ADS–B.

The elements of a realistic plan for ADS–B include a clear, lucid articulation of requirements, benefits, and costs for airspace users to purchase and install new avionics. This plan should also include milestones for completing a number of critical efforts, including the following:

- Modifying existing controller automation systems.
- Finalizing technical requirements for ADS–B "Out" and ADS–B "In."
- Certifying ADS–B related equipment on the aircraft in the United States.
- Approving separation standards for using ADS–B to manage traffic.
- Completing controller training programs for relying on ADS–B systems.

The air-to-air benefits of ADS–B are significant but rely on both ADS–B "Out" and ADS–B "In." FAA's proposed rule only mandates ADS–B "Out," or the broadcast of information to ground systems. The potential for ADS–B "In" relies on the fact that information on nearby aircraft will be delivered to the cockpit. This gives the pilot a second set of eyes, thereby enhancing situational awareness and safety in the air and on the ground. Therefore, we believe FAA needs to accelerate efforts to finalize requirements for ADS–B "In."

Questions submitted by Representative Ralph M. Hall

Q1. With upcoming change in Administrations, do you foresee difficulties maintaining program continuity during the transition? Does NextGen have enough traction among participating agencies to maintain momentum in the months ahead?

A1. It will be a challenge to maintain program continuity during the upcoming transition. This is the case for major initiatives across the Federal Government. In our forthcoming report on the top management challenges facing the department, we will highlight the importance of managing and reducing risk with NextGen. It will be important for FAA and the JPDO to complete several actions, including establishing funding priorities for NextGen.

To maintain traction with NextGen and continue cooperation among JPDO's partner agencies, the next Administration will have to emphasize its commitment to a multi-agency approach. This will be important given the cross-cutting nature of NextGen, resource constraints facing the government, and the expected sharp competition for funds. As noted in our statement, much work remains to be done to fully link and integrate agency budgets and address research gaps for the development and execution of NextGen.

Q2. The joint Planning and Development Office is a planning and coordinating body that relies on the cooperation of its federal partners to provide the expertise and resources needed to accomplish NextGen. With slightly more than four years of experience, how would you rate the effectiveness of the JPDO, especially with regard to engaging and sustaining the cooperation of participating federal agencies? What concerns, if any, do you have about the JPDO's effectiveness following the reorganization?

A2. The JPDO has been effective in engaging and cooperating with participating agencies, including the National Aeronautics and Space Administration and the Department of Defense. The JPDO's efforts to leverage research at other federal agencies are critical given that FAA conducts very little long-term air traffic management research.

Central to making the JPDO an effective multi-agency vehicle is the alignment of resources. This is a complex task, and the JPDO has no authority to adjust or direct the research efforts of other federal agencies.

As noted in our statement, we have seen progress with various mechanisms of alignment, including the publication of a NextGen Concept of Operations and NextGen Research and Development Plan. However, FAA and the JPDO partner agencies need to address several fundamental issues to ensure that research efforts are aligned and successfully transferred to the NAS. For example, there are 27 "disconnects" or "gaps" that need to be addressed, which will fundamentally affect the cost and schedule for NextGen. We provide details on these issues in our statement.

It is premature to evaluate the effectiveness of the recent organizational changes that places the JPDO within the FAA Air Traffic Organization. However, it gives the appearance that the JPDO has been reduced in stature and importance. We are concerned about the fragmentation of budget authority and accountability as well as how the new organization will deal with cross-cutting agency issues. We think FAA will have to revisit how the Agency is organized once it has a clearer picture of what it will take to deliver NextGen capabilities.

Q3. The ADS–B program is fundamental to NextGen. What are the major risks with ADS–B in terms of capabilities, schedule, cost, and industry acceptance?

A3. The implementation of ADS–B and cockpit displays offer significant potential to enhance safety and boost capacity. However, the introduction of this technology faces the following risks.

- Stakeholder acceptance and aircraft equipage—FAA plans to mandate ADS–B but unresolved questions exist about the cost of new avionics and the lack of benefits.
- Frequency congestion concerns—There are real concerns that the frequency planned for large commercial aircraft will become over crowded. This is particularly a concern for high activity airspace in the Northeast United States.
- Finalizing requirements for ADS–B and cockpit displays—FAA must finalize requirements for both ADS–B "Out" (the broadcast of information to ground systems) and ADS–B "In" (the display of information in the cockpit).
- Integrating ADS–B with existing systems—FAA must successfully integrate ADS–B with existing controller displays and computers across the National Airspace System.
- Addressing security concerns—Because ADS–B could make the position of aircraft generally available, security risks need to be fully explored and mitigated.

FAA published a notice of proposed rule-making for ADS–B in October 2007 and received over 170 comments from organizations or individuals. FAA is reviewing the comments and working with industry to resolve several complex issues and risks. We plan to issue a report on ADS–B early next year.

Question submitted by Representative Laura Richardson

Q1. Has the gap analysis been conducted that you referenced on April 14, 2008?

A1. FAA is conducting the gap analysis as recommended in our April 14, 2008, report. According to FAA officials, the analysis of "gaps" between current systems and NextGen is expected to be completed by February 2009. We will continue to monitor FAA's efforts in this area.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Paul G. Kaminski, Chairman and CEO, Technovation, Inc.; AIA Member of NextGen Institute Management Committee

Questions submitted by Chairman Bart Gordon

Q1. How challenging is the JPDO's role in consolidating and focusing the research and development work of so many agencies without having budgetary control over their work? How does this compare with your experience at DOD?

A1. From my experience, I know how challenging budgetary control issues can be, and this is especially so with a multi-agency endeavor such as JPDO. Each JPDO partner agency has its own executive mission, and I doubt that—given JPDO actions to date—providing direct JPDO budgetary authority over partner agencies' R&D is realistic. However, some level of oversight of participating agencies budgets for NextGen R&D to support the critically needed planning, system engineering, and integration of R&D efforts might be helpful.

Q2. In the transformed NextGen, I understand that roles and responsibilities of key players will change dramatically. Pilots will take more separation responsibilities and automation will enable air traffic controllers to manage larger numbers of aircraft while improving safety.

A2. Reallocation of airborne and ground responsibilities is an issue that FAA had anticipated, and it directed its efforts accordingly. One factor in this is the extent of equipage which will determine where, when, and how responsibility will be delegated. Pilots and controllers have to be consulted and trained for their new missions involving new technology and new approaches to improve efficiency and safety. There will also be new responsibilities in a world of substantially different aircraft types such as Unmanned Aerial Systems.

Q2a. What are the key aspects from human factors research that FAA and NASA need to get right before we can have confidence that this delegation of decision-making duties is both feasible and safe?

A2a. In support of the relevant human factors research that you raised, I believe that we need to develop the modeling and simulation capabilities that I described in the briefing attached to my statement. These capabilities will allow us to validate our models by using live demonstrations, to include "humans in the loop" so we can validate operational performance in realistic environments. This will be critical to development and implementation of the policies and certification standards that are needed to obtain the efficiency and safety benefits associated with the enhanced automation enabled by new technology and new system approaches.

Q2b. Are the needed R&D programs in place and adequately funded to get that research done?

A2b. Many of the R&D programs are in place. But I believe additional programs are needed to fill voids and, most importantly, we need a better integration of our modeling and simulation capabilities and related demonstrations across the entire NextGen domain. It will be important for this Committee to review the next budget for modeling and simulation capabilities in this context.

Q3. You advocate bolstering demonstration with modeling and simulation to gain a better understanding of benefits and limitations from anticipated technology improvements. Since FAA does not currently have a significant indigenous modeling and simulation capability, when do you see the agency being capable of performing such research? Or should this research be carried out by NASA or another entity?

A3. FAA, as the implementing agency that does near- and mid-term planning, should direct and coordinate NextGen modeling and simulation activities, and oversee the validation of models and simulations with demonstrations. From my extended and ongoing discussions with FAA, the agency officials are very aware of current limitations in this arena. There is extensive modeling and simulation capability at the FAA Technical Center in Atlantic City. I have met with the Director of that facility, and look forward to making a visit in the near-term to obtain a better understanding of the capabilities and limitations. NASA also has capabilities which should be exploited. Representing AIA, I am continuing to explore ways to assist FAA's expansion and refinement of its capabilities (both internally and externally) by working with NASA, DOD, and industry. The briefing that I provided

along with my statement outlines the approach which I believe is needed both to execute the development and implementation of NextGen and to exploit the substantial long-term benefits that can be provided to the Nation. Accelerating NextGen applications is the goal, and my proposal would enhance current FAA efforts.

Questions submitted by Representative Ralph M. Hall

Q1. With the upcoming change in Administration, do you foresee difficulties maintaining program continuity during the transaction? Does NextGen have enough traction among its particular agencies to maintain momentum in the months ahead?

A1. Since the FAA restructuring bringing closer coordination with JPDO, NextGen is now better positioned to maintain program continuity during an Administration transition. This more efficient integration of JPDO and FAA allows NextGen implementation and near-term planning to be aligned with NextGen R&D and daily air traffic operations into a cohesive whole. This integration will effectively support FAA—the implementing agency—in its responsibility for meeting a challenging R&D and implementation timetable.

JPDO partner agencies are already working with FAA to leverage applicable R&D and facilitate technology transfer in a timely manner. With continued NextGen near-term planning as it transitions to implementation, JPDO participating agencies will be reassured by integration with the implementing agency that will enhance productivity. This closer FAA role will ensure that planning and R&D are prioritized and directly relevant to near-term operational applications. Additionally, partner agencies' participation will be under the rigor and structure of the implementing federal agency to ensure planning is productive and relevant, valuable and appropriate.

Q2. The Joint Planning and Development Office is a planning and coordinating body that relies on the cooperation of its federal partners to provide the expertise and resources needed to accomplish NextGen. With slightly more than four years of experience, how would you rate the effectiveness of the JPDO, especially with regard to engaging and sustaining the cooperation of the participating federal agencies? What concerns, if any, do you have about JPDO's effectiveness following the reorganization?

A2. The JPDO was tasked with an extremely challenging mission and has made a start with issuance of the requisite planning documents. However, these documents do not yet provide the level of detail and the decision-making foundation that were expected and needed by government and industry stakeholders. Consequently, we have lost time and, aside from participating agencies' own planning, JPDO's planning needs more definition. External organizations that have reviewed JPDO documents, such as the National Research Council and the FAA Research, Engineering, and Development Advisory Committee (REDAC), have expressed concern that the documents do not sufficiently define R&D for agencies' action. This concern was amplified by the recently released JPDO Integrated Work Plan that was officially recharacterized as a "planning tool," i.e., not a plan, and presented as one of several approaches to achieve NextGen. However, it was expected that this document would integrate and direct NextGen activities. Participating agencies and companies have been generally disappointed with JPDO progress, with the belief that their efforts have been less than productive. JPDO working groups, led by government and industry co-chairs, have asked that their work be integrated under a unified lead, as most complex development projects are. It was only now, when FAA has been receptive to this request, that their request may be met. This is illustrative of the value that can accrue to JPDO's efforts under closer coordination with FAA: Industry believes that, under closer FAA guidance, it's efforts can be integrated and directed by established planning goals.

I would like to remind the Committee that I would be pleased to provide any further assistance that could be of value, including an informal presentation of my plan to accelerate NextGen development and applications.

How to Accelerate NextGen: What needs to be done

BY DR. PAUL G. KAMINSKI

To accelerate NextGen implementation, there are clusters of essential modifications that must be realized:

- NextGen foundational programs need near-term demonstrations linked with modeling and simulation, and validated by testing;
- The demonstrations can then be expanded and extended in an integrated environment;
- We need to begin now with operational demonstrations (building on existing FAA Test Beds) with stay-behind capabilities that are then replicated and integrate; and
- We need to build an acquisition and system engineering base for people to gain domain experience at test bed demonstration locations.

We also need to attain consensus on selection criteria for near-term demonstrations. I suggest criteria such as capacity enhancement, energy efficiency, improved safety and/or security, environmental impact, implementable within the next five years, and a favorable benefit/cost ratio.

The carefully selected demonstrations will provide us with the information to link foundational programs with enabled NextGen applications and criteria.

Foundational Programs

- ADS–B
- RNP/RNAV
- Surface Management System
- SWIM
- DataComm

Enabled Applications

- CDAs/Tailored Arrivals
- Closely Spaced Parallels
- CDTI assisted approaches

Criteria

- Capacity enhancing
- More energy efficient
- Improved safety/security
- Environmentally sound
- Implementable in the next five years
- Favorable benefit/cost ratio

The selected FAA test beds and demonstrations will undergo the iterative cycle of planning, design and model, build, test and evaluate, adjust, redesign and refine modeling and simulation, build more, integrate results, and then start over. As I call it, "build a little, test a little."

A tested capability (capability "A") is established in one location and integrated with another location (after testing). This linkage can be expanded to achieve a strategic system engineering model with a regionally linked capability. Another capability is then added to one location and the same process begins with the second capability, adding it as a second capability layered on top of the first one and linked regionally.

This iterative process continues, adding capabilities, expanding the regional linkage, and adding participating users as they see the value of capability equipage.

Appropriate modeling and simulation is key to accelerating progress: it provides the systems engineering foundation needed to support and integrate acquisition; it helps establish priorities for achieving the best payoff, and helps define policies and procedures to achieve the objectives (energy and operational efficiency, environmental improvement, improved safety and security; iterative modeling and simulation enables systematic improvements, promotes a common understanding of complex new capabilities, their value added, and mutual interaction; when validated by testing, modeling and simulation demonstrate the value proposition and link incremental improvements to the business case; and data from modeling and simulation

supported by demonstrations will yield the rationale and business case to replace unnecessary legacy systems.

There are specific requirements to execute this acceleration of NextGen capabilities. These requirements are a strategic systems engineering foundation (enabled by modeling and simulation) to refine operational planning and requirements, set priorities, develop system specifications, and support deployment planning; systems acquisition experience and discipline to enhance JPDO planning and FAA implementation processes; systems acquisition/integration management expertise to manage JPDO working groups, and mature IWP and modeling & simulation architecture; a systems acquisition manager under FAA ATO/COO with subordinate program managers for major programs; consortia and individual supporting industry contractors to implement NextGen (e.g., ADS–B contract consortium); and immediate start with operational demonstrations of foundational technology programs with stay behind capabilities, which will then be replicated.

In summary, as the first step, we need to build the "Scaffolds" (i.e., demonstrate and model the applications enabled by foundational programs in an integrated approach) to support the NextGen Vision. Then we must strengthen the scaffold's three "Pillars": 1) System Engineering supported by robust modeling and simulation capability to support the other two Pillars, and to refine the architecture and integrate technologies; 2) System Acquisition and Integrated Management at FAA and other implementing agencies; and 3) Deployment Planning to include operational concepts, safety, procedures, training and security.

AEROSPACE INDUSTRIES ASSOCIATION

How to Accelerate NextGen? What Needs to be Done

Dr. Paul Kaminski

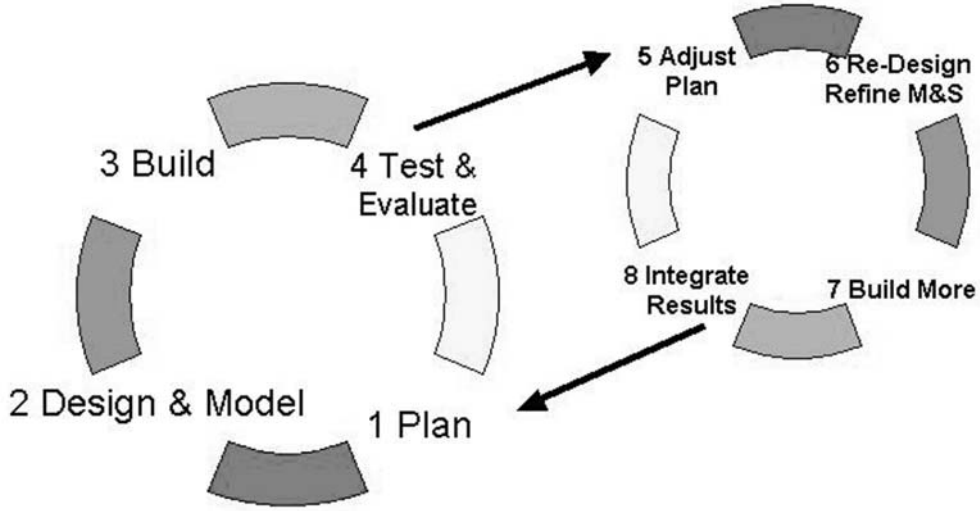
IMC & ExComm Member
Representing AIA

September 11, 2008

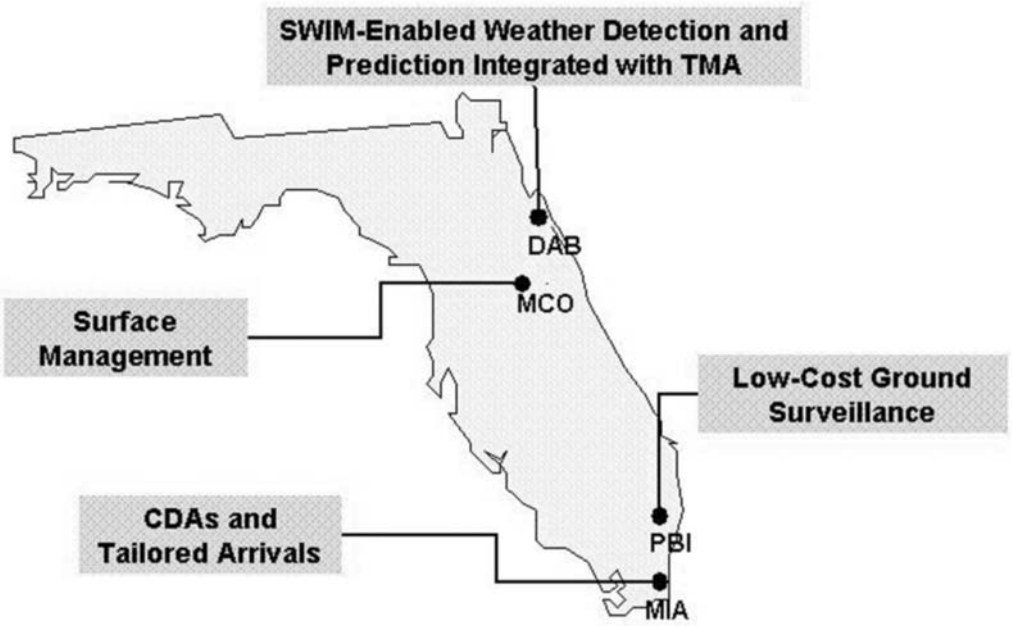
Essential Modifications

- NextGen Foundational Programs Need Near-Term Demos linked with Modeling & Simulation and Validated by Testing
- The Demos can then be Expanded and Extended in an Integrated Environment
- Begin Now with Operational Demonstrations (Building on Existing FAA Test Beds) with Stay Behind Capabilities, then Replicate & Integrate
- Build Acquisition & System Engineering Base- People gain domain experience at test bed demonstration locations

Iterative M&S Cycle

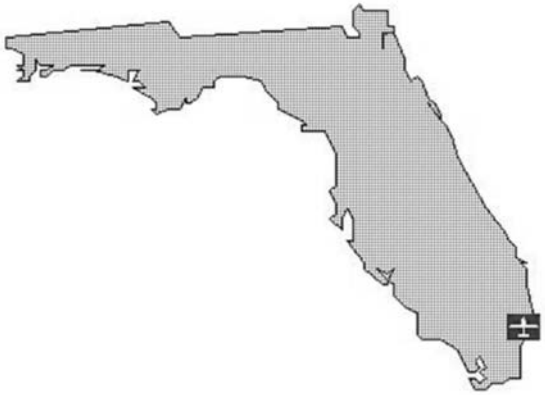


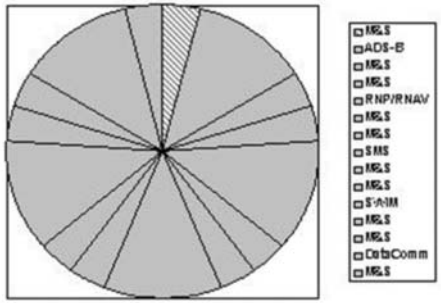
FAA Test Beds & Demonstrations



Initial ADS-B Roll-Out Capability

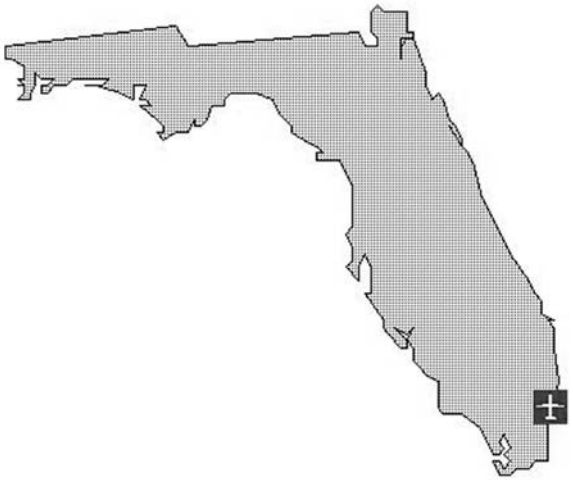
Notional – Not Necessarily choosing MIA

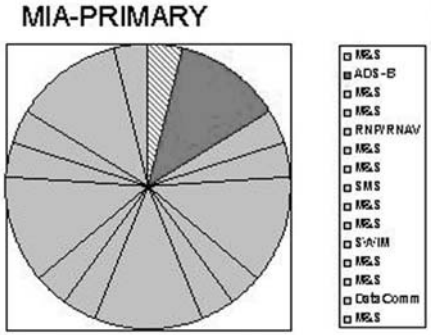




At this stage the M&S preparation to demonstrate ADS-B is represented in the shaded slice.

ADS-B Demonstration

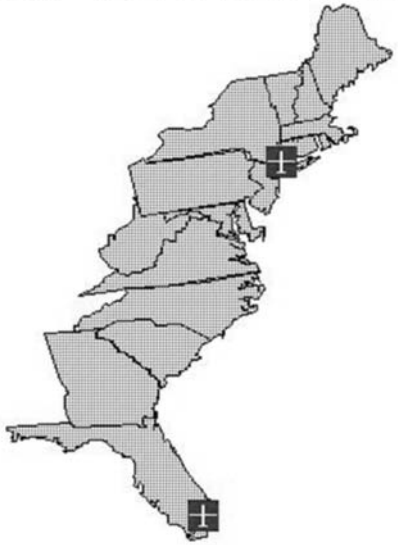


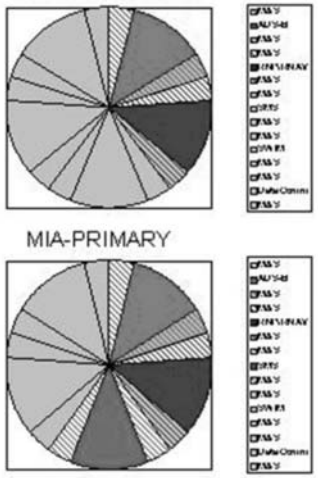


The large slice is representing the actual ADS-B demonstration.

NOTIONAL

Further Continued Integrated Iterations

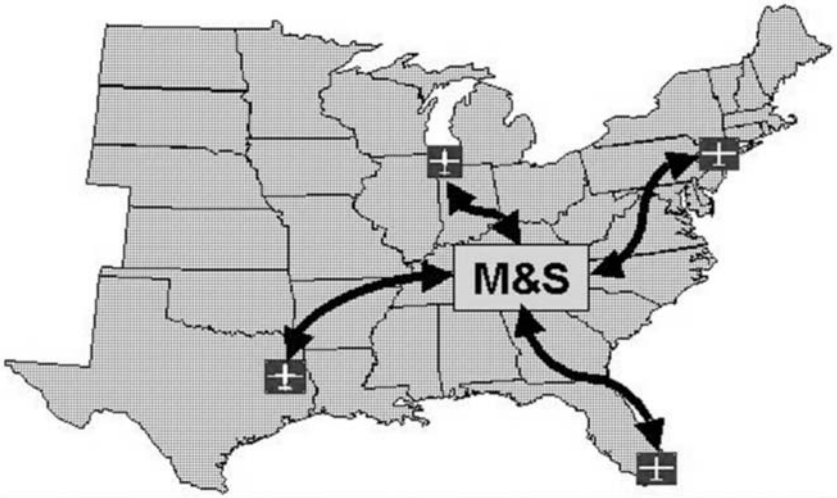




The primary box shows continued M&S with additional technologies while we begin implementing foundational results at a new test bed location.

NOTIONAL

The Collective M&S is a Key Enabler of Sound System Engineering



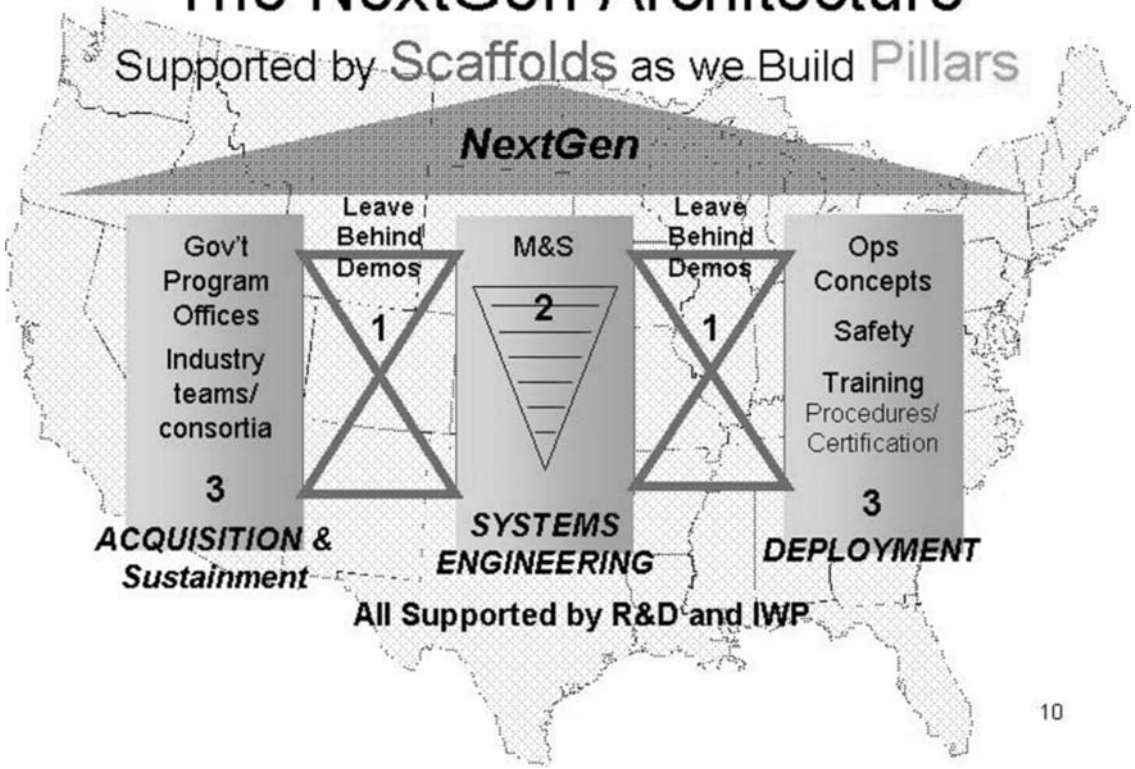
Once this is achieved the Strategic System Engineering Model will be Open to All Stakeholders.

Why Modeling & Simulation

- M&S Provides the Foundation for Systems Engineering Needed to Support Acquisition & Link to Implementation
- M&S Will Help Us Establish Priorities for Achieving the Best Payoff, and Help Define Policies & Procedures to Enhance Safety, Security and Operations
- Using Iterative M&S Enables Systematic Improvements, Promotes a Common Understanding of Complex New Capabilities, their Value Added, and Mutual Interaction
- M&S which is validated by testing is Key to Demonstrating the Value Proposition and Linking Incremental Improvements to the Business Case
- Data From M&S Supported By Demos Will Yield the Rationale and Business Case to Replace Unnecessary Legacy Systems

The NextGen Architecture

Supported by Scaffolds as we Build Pillars



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What's Needed to Execute?

- Strategic Systems Engineering Foundation (Enabled by M&S) To Refine Operational Planning & Requirements, Set Priorities, Develop System Specs, & Support Deployment Planning
- Systems Acquisition Experience and Discipline to Enhance JPDO Planning and FAA Implementation Processes
  - Systems Acquisition/Integration Management Expertise Needed to Manage JPDO govt./industry Working Groups and Mature IWP and Modeling & Simulation (M&S) Architecture
  - Systems Acquisition Manager Assigned Under FAA ATO/COO With Sub-ordinate Program Managers For Major Programs
    - Consortia and individual supporting industry contractors to implement NextGen (ADS-B contract consortium a good example)
- Begin now with operational demonstrations of foundational technology programs with stay behind capabilities, then replicate

In Conclusion, We Need:

- To Build the "Scaffolds" (Demonstrate and Model the Applications Enabled by Foundational Programs in an Integrated Approach) To Support the NextGen Vision as the First Step
- Then Strengthen the Three "Pillars"
  - System Engineering Supported by Robust M&S Capability to Support the Other 2 Pillars, Refine the Architecture & Integrate Technologies
  - System Acquisition & Integrated Management at FAA and Other Implementing Agencies
  - Deployment Planning to Include Operational Concepts, Safety, Procedures, Training & Security

Backup Charts

Need Consensus on Selection Criteria for Near -Term Demos

Some Suggested Criteria

- Capacity Enhancing
- More Energy Efficient
- Improved Safety/Security
- Environmentally Sound
- Implementable in the Next 5 years
- Favorable Benefits/Costs Ratio

Demos Provide Means To Link Foundational Programs With Enabled Applications & Criteria

Foundational Programs

- ADS-B
- RNP/RNAV
- Surface Management System (SMS)
- SWIM
- DataComm

Enabled Applications

- CDAs/Tailored Arrivals
- Closely Spaced Parallels
- CDTI assisted approaches

Criteria

- Capacity Enhancing
- More Energy Efficient
- Improved Safety/Security
- Environmentally Sound
- Implementable in the Next 5 years
- Favorable Benefits/Costs Ratio

Creating Deliverable in 2008

(Notional Example)

- Take the FAA Southern Florida Initiative and lay down ADS-B with RNAV/RNP Iteration
- Use Demo to Assess Benefits & Limitations of ADS-B and RNAV/RNP to Increase Capacity & Efficiency at MIA
- Capture Demonstration Data and Publish Public Report of Near Term NextGen Foundational Technologies that Can Make a Difference

ANSWERS TO POST-HEARING QUESTIONS

Responses by Ian A. Waitz, PARTNER Director; Jerome C. Hunsaker Professor of Aeronautics and Astronautics; Head, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology

Questions submitted by Chairman Bart Gordon

Q1. The high cost of fuel has forced airlines to remove less fuel-efficient aircraft from their fleets and reduce the number of flights. In the near-term this should result in less fuel consumed and a commensurate decrease in emissions. But airlines are also delaying plans to purchase newer, quieter and more fuel-efficient replacement aircraft. Does the new energy picture alter the thrust and urgency of your team's 2004 report on aviation and the environment?

A1. The new energy picture increases the urgency of the need to jointly address environment and energy issues for air transportation. Two-thirds of every drop of petroleum is used by transportation. The transportation sector is one of the fastest growing major economic sectors with respect to CO_2 emissions. And within the transportation sector, aviation is the fastest growing mode of transportation in many regions of the world. Aviation is also uniquely challenged in terms of opportunities for improvement because of the weight, volume, and safety constraints that come with flight (relative to movement on the surface of the Earth). Further, while commercial air transportation is an industry that is estimated to contribute three percent to eight percent to the U.S. GDP, it is also an industry that is very sensitive to a variety of economic drivers like the price of fuel. As some support for this, note that the historical net operating profits for the industry as a whole are around zero percent. Indeed, the balance with regard to the adoption of more fuel-efficient aircraft that you identify in your question is a reflection of this sensitivity. Never before has there been a more opportune time to jointly promote environment and economy through addressing the challenges of aviation, environment, and energy.

Q2. In a February report to the Subcommittee, GAO reported that noise reduction technologies may be limited by concerns about global warming as advances in these technologies could make it more difficult to also achieve reductions in emissions of greenhouse gases. In your opinion, are reductions in noise and emissions mutually exclusive or could high fuel prices spur technological innovations we have yet to envision?

A2. There are many examples of trade-offs in aircraft and engine technology where improving one thing (e.g., noise performance) penalizes something else (e.g., fuel efficiency and GHG emissions). This is true with many noise reduction technologies. There are also examples of co-benefits, whereby changes to improve fuel efficiency also reduce noise (or other environmental or performance issues)—as was the case with the introduction of the high bypass ratio gas turbine engine in the '70s and '80s. So there is not a "yes" or "no" answer to this question that is always true. Nonetheless, it is true that most design changes for relatively mature, well-developed technologies exhibit negative trade-offs whereby improving one aspect of performance (environmental, safety, economics, etc.) limits other performance objectives. This is a result of aircraft being highly optimized systems refined for specific performance objectives. I wish to emphasize that these trade-offs are most acute for known, and relatively mature technologies. Historically, new and innovative aircraft technology has changed the equation (e.g., by enabling a beneficial step change in several performance objectives at the same time). It is exactly this type of innovation that is required and that should be the focus of more robust, federally funded research and development programs in NASA and FAA.

Q3. In light of the uncertainty associated with how greenhouse gas and other emissions from aviation will be dealt with worldwide, how can the JPDO address the concern that the NextGen initiative is honing in on solutions without a clear idea of the problem?

A3. First, I concur fully with the concern. It is hard to make a case that NextGen is honing in on the right solutions if they don't have a clear idea of the problem. JPDO's understanding of the climate change impacts of aviation is indeed insufficient. As noted in both my written and oral testimony, this should be addressed by funding a scientific research program that focuses on aviation and climate change (one designed specifically to answer the needs of the decision-makers with regard to technology, operational procedures, and policies). This is especially critical because of the unique nature of aviation's impacts on climate. In my mind, this is the

single greatest failing of our national aviation and environment research enterprise today. Climate change is a critical concern that could greatly impact the industry and human health and welfare, we have the talent to answer the important questions and to plot a reasoned, intelligent path forward, yet the work to answer the questions is not being funded. And the magnitude of the funding required (perhaps $5M per year) is embarrassingly small compared to the potential impact of even a single misplaced policy decision on an industry that contributes so much to our well being and economy.

Questions submitted by Representative Ralph M. Hall

Q1. With the upcoming change in Administrations, do you foresee difficulties maintaining program continuity during the transition? Does NextGen have enough traction among its partner agencies to maintain momentum in the months ahead?

A1. We are currently suffering because of inaction in advance of the change in Administration: no new reauthorization for FAA, no new reauthorization for NASA. Within these reauthorization bills are the critical programs required to jointly address aviation and environment. The programs are not going forward under the continuing resolution. Important new programs have been put on hold—programs that were already overdue. A related question is whether the momentum that NextGen has now is sufficient. I believe it is not. So the current momentum is insufficient, and it is being hurt further by inaction surrounding the change in Administration.

Q2. The Joint Planning and Development Office is a planning and coordinating body that relies on the cooperation of its federal partners to provide expertise and resources needed to accomplish NextGen. With slightly more than four years of experience, how would you rate the effectiveness of the JPDO, especially with regard to engaging and sustaining the cooperation of the participating federal agencies? What concerns, if any, do you have about JPDO's effectiveness following the reorganization?

A2. The first two to three years of JPDO as a whole were rough. However, in the last year, I have seen progress being made, especially with regard to coordination between FAA and NASA, which is particularly important in the environmental area. And as I noted in my testimony, within the JPDO, the Environmental Working Group has been a bright spot. However, for the JPDO as a whole, if 1 were to assign a grade, I would give them a C or a D for first couple years, and a B more recently. There is room for improvement. I do not know how this will be impacted by the reorganization of the JPDO.

Q3. You point out that the Europeans are beginning to leap ahead in research on aviation's impact on climate. What are the implications? Does Europe share their research findings broadly, as we do with government funded R&D? Will it affect the competitiveness of American products in the marketplace?

A3. The research findings from European research programs are shared through journal publications and presentations at conferences. These often come a year or two after the work is complete. There are insufficient opportunities for non-EU engagement in the scientific process earlier in the process as the work is being planned and carried out. Such engagement is particularly important for promoting an effective, mutually beneficial, international research enterprise. And even if the sharing of results was immediate, it does not imply that the questions being addressed in their research programs are the same questions that we would want to address. We have different national and local interests, and different opportunities with respect to addressing these interests. Research by proxy for important national issues like air transportation and the environment is not a strong approach in my opinion.

Q4. You state that proposed funding levels for FAA's CLEEN (Continuous Lower Energy, Emissions and Noise) program are insufficient to promote needed technological advances. What level of funding do you consider appropriate?

A4. We need to accelerate the technology, operations, and alternative fuels programs in *both* NASA and FAA with an emphasis on programs that bridge fundamental aeronautics research and industrial development programs. FAA's CLEEN program funding should not be considered in a vacuum without the context of funding for parallel NASA programs. I believe that something on the order of $0.5B per year should be invested in jointly addressing aviation and environment with approximately 20 percent invested on the FAA side and 80 percent on the NASA side.

With respect to NASA funding, I am pleased to note that this parallels recommendations made in various versions of the pending reauthorization bills. With respect to FAA, it is a factor of two or three higher than proposed in the pending reauthorization bills.

Q5. Based on research to date, have any estimates of the cost of producing alternative fuels been provided if industry were to embrace full-scale production?

A5. Yes, production cost estimates have been provided by researchers in industry, governmental agencies, and academia for several potential alternative fuels. However, because of the multiple potential alternative fuels, there is a wide range of estimated production costs. These production costs depend heavily on the choice of feedstock (e.g., coal, natural gas, solid biomass, and algal oil) and the process that is used to convert the feedstock into an alternative fuel (e.g., Fischer-Tropsch synthesis, or hydro-processing). The production costs are currently estimated to be larger than those for petroleum, but for fuel prices at or above those we have seen recently, production of fuels from some of the alternative feedstocks appears to economically attractive. Production cost estimates will always have uncertainties associated with them; this uncertainty will decrease as more is known about the processes.

Appendix 2:

Additional Material for the Record

United States Government Accountability Office

GAO

Report to Congressional Requesters

September 2008

NEXT GENERATION AIR TRANSPORTATION SYSTEM

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

GAO
Accountability * Integrity * Reliability

GAO-08-1078

September 2008

GAO
Accountability•Integrity•Reliability

Highlights

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

NEXT GENERATION AIR TRANSPORTATION SYSTEM

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

Why GAO Did This Study

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

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

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

What GAO Found

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

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

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

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Abbreviations

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

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GAO
Accountability * Integrity * Reliability
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Congressional Requesters

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

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

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

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

Results in Brief

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

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

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

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

Background

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

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

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

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

[2]GAO-05-331.

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

In addition to our recommendations and those of the Department of Transportation Inspector General[3] for improving FAA's acquisition management, Congress and others have taken steps to address these issues. For example, in 1997, the congressionally appointed National Civil Aviation Review Commission recommended, among other things, that FAA's management become more performance-based. In December 2000, President Clinton signed an executive order, and Congress passed supporting legislation that, together, provided FAA with the authority to create the performance-based ATO to control and improve FAA's management of the modernization effort. FAA reorganized, transferring 36,000 employees, most of whom worked in air traffic services and research and acquisitions, to ATO in February 2004. By creating ATO, headed by a chief operating officer, FAA established a new, flatter organizational structure and adopted more leading practices of private sector businesses to address the cost, schedule, and performance shortfalls that have plagued ATC acquisitions.

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

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

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

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

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

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

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

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

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

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

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

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

- Established a capital investment team to review financial and performance data. These reviews provide early warnings of potential problems as well as help to develop corrective actions.

- Implemented earned value management on all new major acquisitions as a way to prevent, detect, report, and correct problems in acquiring major systems and to ensure that major programs are within budget and schedule targets.[7] While ATO has taken important steps to implement earned value management policies, we have found that it needs to strengthen its policies governing earned value management and add rigor to its oversight processes.[8]

- Developed and applied a process improvement model in a number of software-intensive system acquisitions, resulting in, among other things, enhanced productivity and greater ability to predict schedules and resource needs.

- Undertaken human capital initiatives to improve its acquisition workforce culture and build toward a results-oriented, high-performing organization.

- Established annual acquisition performance goals to improve oversight and accountability over acquisition processes.

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

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

[8]GAO-08-756.

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

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

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

Figure 1: Standard Terminal Automation Replacement System Controller Workstation

Source: FAA.

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

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

[10]GAO-08-42.

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

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

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

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

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

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

Thirteen of 15 industry stakeholders[13] who discussed the issue raised concerns over what they perceive as a lack of impact on NextGen planning from their participation in the NextGen effort so far. Stakeholders can provide input into NextGen planning through participation in JPDO working groups and the NextGen Institute. JPDO's organizational structure includes nine working groups[14] that were created[15] to bring together federal and nonfederal experts to plan for and coordinate the development of NextGen systems. Similarly, the NextGen Institute was established to incorporate the expertise of industry, state and local governments, and academia into the NextGen planning process. The Institute Management Council, composed of top agency officials and representatives from the aviation community, oversees the policy, recommendations, and products of the institute and provides a means for advancing consensus positions on critical NextGen issues. All of the stakeholders we interviewed, with the exception of stakeholders from an FAA employee union—the Professional Aviation Safety Specialists (PASS)—indicated that they participated in NextGen planning and development activities as members of various JPDO working groups, as members of the Institute Management Council, or by serving as consultants to FAA. Stakeholders from the National Air Traffic Controllers Association (NATCA)—another FAA employee union—indicated that while the union does participate in FAA meetings and briefings related to NextGen, their status is that of a recipient of information rather than an equal party with other stakeholders on the development of NextGen.

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

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

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

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

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

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

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

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

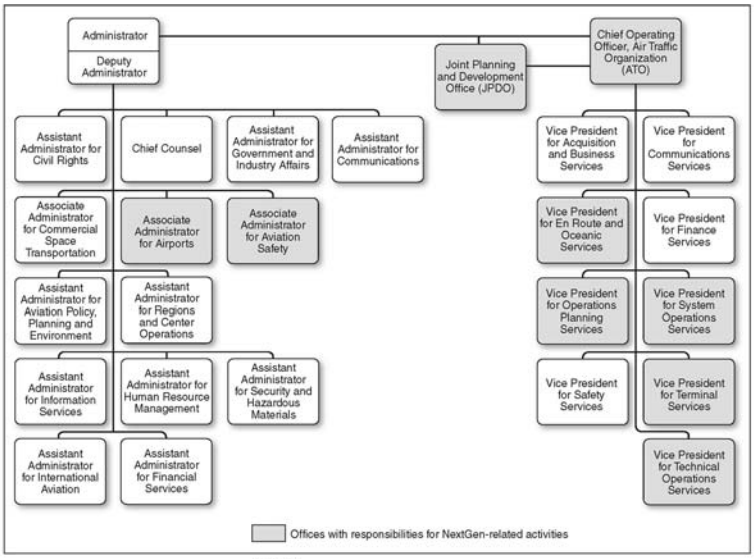
In addition, the Senate Appropriations Committee has expressed concern that the JPDO planning documents lack details on how the various NextGen initiatives will reduce delays and congestion between now and 2025. It would have FAA and JPDO include in future budget justifications and NextGen planning documents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

improvements and delay reduction measures will start to relieve congestion.

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

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

Figure 2: FAA Organization, November 2007



Source: FAA.

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

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

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

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

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

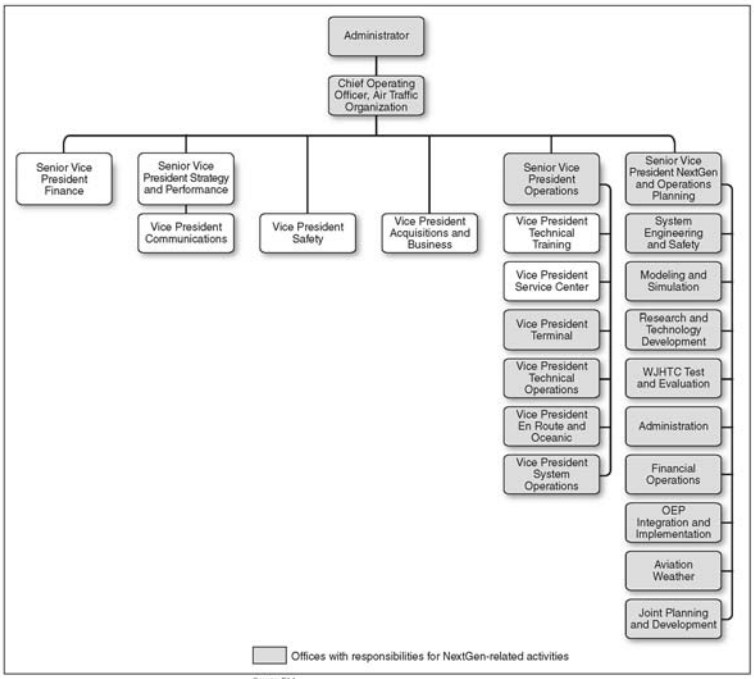
[17]GAO, *Responses to Questions for the Record; Hearing on JPDO and the Next Generation Air Transportation System: Status and Issues*, GAO-07-918R (Washington, D.C.: May 29, 2007).

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

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

[18]H.R. 2881, § 202.

Figure 3: ATO Organization, July 2008



Source: FAA.

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

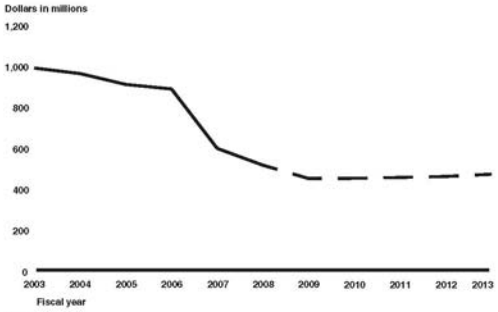
FAA's Ability to Implement and Obtain Expected Benefits from NextGen Will Be Affected by Research and Development, Human Capital, and Infrastructure Challenges

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

Research and Development Funding Uncertainties and Research Gaps Exist

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

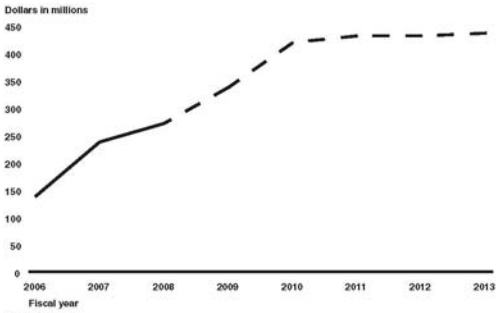
Figure 4: NASA's Aeronautics Research Budget for Fiscal Years 2003 through 2008 and Proposed Budget through Fiscal Year 2013, in Constant 2008 Dollars



Source: GAO analysis.

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

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



Source: GAO analysis

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

[19]H.R. 2881, § 505.

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

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

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

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

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

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

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

Regional Demonstrations Could Accelerate Integration and Adoption of NextGen Technologies

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

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

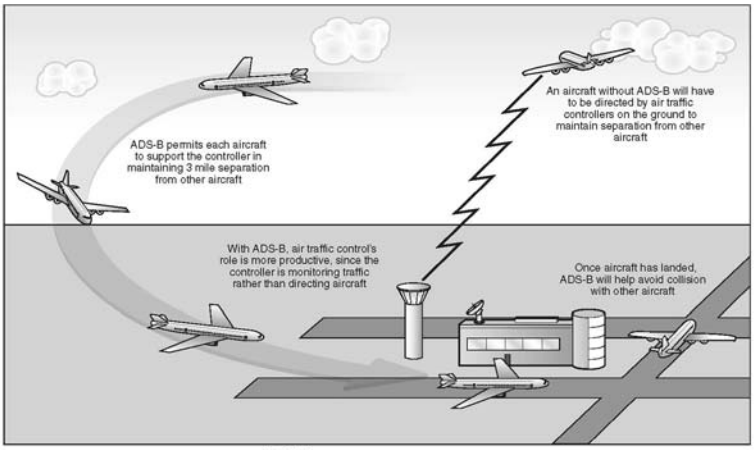
(CDA)[23] procedures in use in Los Angeles and Louisville and Automatic Dependent Surveillance-Broadcast (ADS-B)[24] in Alaska. In addition, FAA is working with a few airlines, such as United Parcel Service (UPS), which is installing ADS-B on all of its Boeing 757 and 767 aircraft. The equipment will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

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

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

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

Figure 6: Example of Use of ADS-B



Source: GAO

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

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

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

Along these lines, in June 2008, FAA signed a memorandum of agreement with the state of Florida and DayJet—a carrier that provides air taxi[27] service—to establish a government and industry partnership for demonstrating NextGen technologies prior to national implementation. For the Florida demonstration, FAA, together with aviation equipment manufacturers and municipalities, will use the NextGen capabilities of ADS-B, RNAV, and RNP for an on-demand air taxi fleet's operations. As other NextGen capabilities, such as System-Wide Information Management (SWIM),[28] are deployed and if the air taxi fleet's operations move to other airports and regions, the demonstration is expected to be expanded to include those new capabilities and other airports and regions. In addition, in June 2008, FAA signed an agreement with Embry-Riddle Aeronautical University to Support future research and demonstrations that are expected to lead to proof of concept and early implementation of NextGen capabilities, according to FAA. According to the airlines and other stakeholders we interviewed, a demonstration of the integration of NextGen capabilities and of efficiencies resulting from their use would give airlines an incentive to equip their aircraft with NextGen technologies. They could then lower their costs by reducing their fuel consumption and decrease the impact of their operations on the environment. Our research indicate that such regional or targeted demonstrations could accelerate the delivery of NextGen benefits while helping to ensure safe operations within the current system. By establishing benefits early in a program's development, demonstrations can increase stakeholders' confidence in the overall NextGen initiative and provide incentives for the aviation community to equip aircraft with compatible technology.

NextGen Will Require New Skills and Abilities of FAA Personnel

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The increases in capacity expected from the High-Density Terminal and Airport Operations initiative are not likely to be sufficient to handle the expected increases in traffic. As a result, new or expanded runways will likely be needed. FAA has developed a rolling 10-year plan for capacity improvements at the nation's 35 busiest airports, and some airports are building new runways. Moreover, FAA simulated the expected capacity enhancement of these currently planned runway improvements and the additional capacity gained through the implementation of some NextGen initiatives[32] and found that by 2025, 14 airports will still need additional capacity. In addition, building new runways at some of these airports will present considerable obstacles. The 14 airports are as follows:

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

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

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

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

Agency Comments

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

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

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

Gerald L. Dillingham

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

List of Requesters

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

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

The Honorable John D. Rockefeller, IV
Chairman
The Honorable Kay Bailey Hutchison
Ranking Member
Subcommittee on Aviation Operations, Safety, and Security
Committee on Commerce, Science, and Transportation
United States Senate

The Honorable Jerry F. Costello
Chairman
The Honorable Thomas Petri
Ranking Republican Member
Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

Appendix I: Scope and Methodology

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

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

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

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

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

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

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

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

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

We conducted our performance audit from July 2007 to September 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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

Appendix II: Stakeholder Responses to Semistructured GAO Interview Questions

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

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

Source: GAO.

Appendix III: ATC Acquisition Performance

(Dollars in millions)

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

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

Source: FAA.

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

(Dollars in millions)

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

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

Source: GAO analysis of FAA data.

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

[a]APB: acquisition program baseline.

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

Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

Gerald L. Dillingham, Ph.D., (202) 512-2834 or dillinghamg@gao.gov

Acknowledgments

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

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