

June 2011

NEXTGEN AIR TRANSPORTATION SYSTEM

Mechanisms for
Collaboration and
Technology Transfer
Could Be Enhanced to
More Fully Leverage
Partner Agency and
Industry Resources



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Why GAO Did This Study

The Federal Aviation Administration (FAA) is developing and implementing a broad transformation of the national airspace system known as the Next Generation Air Transportation System (NextGen). NextGen is a complex undertaking that requires new technologies and supporting infrastructure and involves the activities of several agencies as well as private industry.

This report provides information on the effectiveness of (1) FAA's and the federal partner agencies' mechanisms for collaborating and leveraging resources to develop and implement NextGen, and (2) FAA's mechanisms for working with and transferring technology to or from private industry. To do this, we assessed FAA and partner agency mechanisms against applicable agreements, the agencies' own guidance for these activities, as well as applicable key practices that GAO has reported can enhance federal collaborative efforts.

What GAO Recommends

GAO recommends that FAA and the Departments of Defense (DOD) and Homeland Security (DHS) work together to develop mechanisms that will enhance collaboration and technology transfer between the agencies. GAO and others have outstanding recommendations related to interaction with industry that FAA has begun to address and GAO makes no further recommendations in this report. DOD and DHS concurred with the recommendation, while FAA did not comment on whether or not it agreed.

View [GAO-11-604](#) or key components. For more information, contact Gerald Dillingham, Ph.D., at (202) 512-2834 or dillinghamg@gao.gov.

NEXTGEN AIR TRANSPORTATION SYSTEM

Mechanisms for Collaboration and Technology Transfer Could Be Further Enhanced to More Fully Leverage Partner Agency and Industry Resources

What GAO Found

Some mechanisms for FAA and partner agency collaboration are effective, though others fail to ensure research and technology from the partner agencies and industry are fully used by FAA. Some mechanisms used by FAA and the National Aeronautics and Space Administration (NASA) for coordinating research and transferring technology are consistent with several key practices in interagency coordination. For instance, FAA and NASA use research transition teams to coordinate research and transfer technologies from NASA to FAA. The design of these teams is consistent with several key practices GAO has identified in previous work that can enhance interagency coordination, such as identifying common outcomes, establishing a joint strategy to achieve that outcome, and defining each agency's role and responsibilities. This allows the agencies to overcome differences in mission, culture, and ways of doing business. However mechanisms for collaborating with other partner agencies do not always ensure that FAA effectively leverages agency resources. For example, the mechanisms used by FAA, DOD, and DHS have not yet resulted in a full determination of what research, technology, or expertise FAA can leverage to benefit NextGen. Further, collaboration between FAA, DOD, and DHS may be limited by differing priorities. Finally, FAA and the Joint Planning and Development Office—an interagency organization created to plan and coordinate research for NextGen—have not fully coordinated the partner agencies' research efforts, though they are working to address research gaps. A lack of coordination could result in a duplication of research or an inefficient use of resources.

Numerous mechanisms are available to FAA to collaborate with industry to identify and transfer technology to advance NextGen, but some lack flexibility and outcomes can be unclear. Within its Acquisition Management System (AMS), FAA may use several mechanisms at various stages to conduct outreach, collaborate with private-sector firms, or transfer technology. In particular, FAA may use several types of research and development agreements between itself and the private sector as mechanisms to facilitate technology transfer. However, stakeholders said that the system can lack flexibility, in some circumstances, to consider alternative technologies or new ideas once the process is underway. GAO has made recommendations in the past to improve FAA's AMS system. FAA has begun to implement these recommendations. FAA is beginning to use a new, possibly more flexible, contracting vehicle—Systems Engineering 2020—to acquire the research, development, and systems engineering support to integrate NextGen concepts. FAA also reviews unsolicited proposals as a mechanism for private industry to offer unique ideas or approaches outside of the competitive procurement process. However, FAA's unsolicited proposal process is not a significant source of new technology for FAA. Other mechanisms such as outreach events with private industry and NextGen test facilities might enhance knowledge and result in technology transfer, but outcomes, such as specific benefits, from some of these mechanisms can be unclear.

Contents

Letter		1
	Background	5
	Some Mechanisms for Partner Agency Collaboration Are Effective, While Others Fail to Ensure Resources Are Being Leveraged	8
	Numerous Mechanisms Are Available to Collaborate with Industry and to Identify and Transfer Technology, but Some Lack Flexibility and Outcomes Can Be Unclear	19
	Conclusions	27
	Recommendation for Executive Action	29
	Agency Comments and Our Evaluation	30
Appendix I	Comments from the Department of Defense	32
Appendix II	Comments from the U.S. Department of Homeland Security	34
Appendix III	GAO Contact and Staff Acknowledgments	36
Tables		
	Table 1: Examples of Mechanisms to Facilitate Technology Transfer That May Be Used within Selected AMS Phases	20
	Table 2: FAA's Four Most Commonly Provided Reasons for Not Accepting Unsolicited Proposals	23
Figures		
	Figure 1: Examples of Partner Agency Responsibilities for NextGen Technology Research and Development	7
	Figure 2: Partner Agency and Private Sector Involvement in Weather Technologies	13

Abbreviations

AMS	Acquisition Management System
DHS	Department of Homeland Security
DOD	Department of Defense
FAA	Federal Aviation Administration
JPDO	Joint Planning and Development Office
NAS	national airspace system
NASA	National Aeronautics and Space Administration
NextGen	Next Generation Air Transportation System
NOAA	National Oceanic and Atmospheric Administration
SE 2020	Systems Engineering 2020

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United States Government Accountability Office
Washington, DC 20548

June 30, 2011

The Honorable John L. Mica
Chairman
Committee on Transportation
and Infrastructure
House of Representatives

The Honorable Thomas E. Petri
Chairman
Subcommittee on Aviation
Committee on Transportation
and Infrastructure
House of Representatives

The Federal Aviation Administration (FAA) predicts that, by 2031, the annual number of airline passengers in the United States will increase 78 percent—from 712.6 million in 2010 to about 1.27 billion in 2031. To meet these growing demands, while simultaneously improving safety, efficiency, and environmental performance, FAA is developing and implementing a broad transformation of the national airspace system (NAS), known as the Next Generation Air Transportation System (NextGen). NextGen is a complex undertaking that requires new technologies—including new integrated ground and aircraft systems—as well as new procedures, processes, and supporting infrastructure to create an air transportation system that will rely on satellite-based surveillance and navigation, data communications, and improved collaborative decision-making. Transforming the nation's air transportation system impacts and involves the activities and missions of several federal agencies. In recognition of this, NextGen was designed as an interagency effort to ensure coordination across agencies and leverage various agencies' expertise, research, technologies, and funding to advance NextGen while avoiding duplication. Federal partner agencies identified in NextGen's initial legislation¹ include FAA; the Department of Commerce; the Departments of Defense (DOD) and Homeland Security (DHS); and the National Aeronautics and Space Administration (NASA). FAA is the lead implementer and its Joint Planning and Implementation Office (JPDO) is

¹Vision 100—Century of Aviation Reauthorization Act (Pub. L. No. 108-176, §709 117 Stat. 2490 (2003)).

the primary agency planner. In addition to these federal partner agencies, NextGen was also intended to be developed in collaboration with the aviation and aeronautics industries and other private-sector stakeholders to facilitate coordinated research activities, to transfer technologies from FAA and partner agencies to the private sector, and to take advantage of research and technology developed by the private sector that could meet NextGen needs, as appropriate.²

FAA is currently implementing foundational systems and technologies that will create the NextGen midterm system through 2018.³ According to a senior FAA official, these planned NextGen improvements are estimated to cost the government \$11 to 12 billion, and result in aircraft equipment costs to private aircraft operators of \$5 to 7 billion.⁴ While many of the specific capabilities and technologies for the midterm system have already been identified and some have been developed, additional knowledge, data, technologies, and integration of systems will be needed to finalize the midterm system. Furthermore, some specific capabilities and technologies that will make up the long-term vision for NextGen (beyond 2018) have yet to be decided. Technology transfer and transition efforts undertaken by FAA in coordination and collaboration with its partner agencies and private industry will help determine how NextGen evolves and develops over the mid- and long-term. Because JPDO, as the primary inter-agency planner, must coordinate the NextGen activities of six agencies, collaboration amongst these agencies is a key component to the successful implementation of NextGen. However, Congress and others have raised questions about whether FAA may be missing opportunities to leverage existing research and technologies being developed and used within the partner agencies and the private sector—opportunities that could potentially reduce the time frames, risks, and costs associated with NextGen development.

²NextGen also involves coordination and harmonization with the international community to ensure interoperability. In Europe, the Single European Sky ATM Research Programme is the effort to improve the European air traffic management system. We currently have a review underway assessing coordination between the U.S. and the European Union on these respective efforts.

³FAA defines the NextGen near- and mid-term time frame as 2010-2018, and the NextGen long-term time frame as beyond 2018.

⁴DOD officials told us that the cost to equip military aircraft with NextGen technology has not generally been included in the cost of NextGen to the government, which could significantly increase the costs of NextGen.

You asked that we review how FAA coordinates with the NextGen partner agencies and private industry to research, develop, and transition the technologies needed to deliver NextGen capabilities. This report provides information about (1) the effectiveness of FAA's and the federal partner agencies' mechanisms for collaborating to research, develop, and transfer technologies for NextGen and leverage agency resources,⁵ and (2) the effectiveness of FAA's internal processes, outreach activities, and other mechanisms for working with and transferring technology to or from private industry.

To understand FAA's mechanisms for collaborating with its federal partner agencies, we obtained and analyzed relevant supporting documentation from FAA, the partner agencies, and other organizations involved in NextGen research, development, and transfer. We interviewed officials from FAA, the partner agencies, and other relevant organizations, including the MITRE Corporation, Massachusetts Institute of Technology Lincoln Laboratories, and FAA's Research, Engineering, and Development Advisory Council. We also interviewed officials from JPDO, which was created to facilitate research coordination and technology transfer with partner agencies as well as the private sector. To provide information on the mechanisms FAA uses to work with private industry, we obtained and analyzed relevant documentation from FAA, JPDO, the NextGen Institute,⁶ and private-sector entities. We interviewed FAA officials in the Office of Research and Technology Development, officials involved in FAA's processes for evaluating unsolicited proposals from private industry, and officials from FAA's NextGen Solution Integration Group. To gather perspectives from the private sector, we interviewed representatives from various firms in the aviation and aeronautics industry, as well as industry

⁵We have previously reported that collaborating agencies should identify the human, information technology, physical, and financial resources needed to initiate or sustain their collaborative effort. Collaborating agencies bring different levels of resources and capacities to the effort. By assessing their relative strengths and limitations, collaborating agencies can look for opportunities to address resource needs by leveraging each others' resources, thus obtaining additional benefits that would not be available if they were working separately. See GAO, *Results Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, GAO-06-15 (Washington, D.C.: Oct. 21, 2005), p. 16.

⁶The NextGen Institute was established in March 2005 through an agreement between FAA and the National Center for Advanced Technologies as the mechanism through which the JPDO would access private-sector expertise for application to NextGen activities and tasks. Participation in the NextGen Institute is open to any individual or entity. The Institute Management Council, which consists of 17 senior leaders from the aviation community, oversees the policy, recommendations, and products of the NextGen Institute.

associations, including the Boeing Company; Honeywell International Inc.; Raytheon Company; RTCA Inc.; the General Aviation Manufacturers Association; Lockheed Martin Corporation; the Aerospace Industries Association; AirDat LLC; ATH Group Inc.; Appareo Systems; Avidyne Corporation; Crown Consulting, Inc.; and L3 Communications Corporation. We also interviewed officials from six companies that submitted unsolicited proposals for aviation technologies to FAA, which FAA responded to in 2009 and 2010. To support both objectives, we visited and interviewed officials at the NASA North Texas Research Station and Embry Riddle Aeronautical University and interviewed the Director of the FAA Technical Center. These locations are all NextGen test facilities that FAA and industry use for the evaluation of NextGen concepts and technology and where technology integration and testing can take place without affecting day-to-day air traffic operations.

For both objectives, we compared FAA and partner agency mechanisms to research, transition, and transfer technology against applicable laws and agreements, the agency's own criteria and guidance for these activities, and because effective transfer of research and technology requires effective collaboration, we applied key practices that GAO has reported can enhance and sustain federal collaborative efforts. These key practices include such things as (1) defining and articulating a common outcome; (2) establishing mutually reinforcing or joint strategies; (3) identifying and addressing needs by leveraging resources; (4) agreeing on roles and responsibilities; (5) establishing compatible policies, procedures and other means to operate across agency boundaries; (6) developing mechanisms to evaluate, monitor, and report on results; (7) reinforcing agency accountability for results; and (8) reinforcing individual accountability for results.⁷ We discuss these criteria to the extent that they apply to technology transfer-related stakeholder collaboration issues that we identified during our review.

We performed our work from May 2010 to June 2011 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient and appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence

⁷GAO, *Results Oriented Government: Practices That Can Enhance and Sustain Collaboration among Federal Agencies*, [GAO-06-15](#) (Washington, D.C.: Oct. 21, 2005).

obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The NAS consists of a wide assortment of technologies operated by FAA, other federal agencies, such as DOD, and industry participants such as airlines. Technology transfer may be defined as the process by which technology or knowledge developed by one entity is applied and used by another. Technology transfer may involve the transfer of equipment, research, architecture, knowledge, procedures, or software code, or involve data integration. Technology transfer also encompasses the process by which research is transitioned from one entity and then developed and matured by another through testing and additional applied research until ultimately deployed. This report focuses on the mechanisms used to transfer research and technology between partner agencies and private industry and FAA, which can include the transfer of FAA and partner agency research to the private sector to develop a technology, or the transfer of research or technology developed by partner agencies or the private sector to FAA.⁸

Since the origination of the NextGen effort, several mechanisms intended to facilitate coordination and technology transfer among FAA and partner agencies have been established. Congress created JPDO within FAA as the primary mechanism for interagency and private-sector coordination for NextGen. JPDO's enabling legislation states that JPDO's responsibility with regard to technology transfer is "facilitating the transfer of technology from research programs such as the National Aeronautics and Space Administration program and the Department of Defense Advanced Research Projects Agency program to federal agencies with operational responsibilities and to the private sector."⁹ JPDO developed an Integrated Work Plan that recommends primary and support responsibilities to partner agencies for research and development of various technological

⁸FAA Order 9550.6A implements the Stevenson-Wydler Technology Innovation Act of 1980, Pub. L. 96-480, as amended (codified at 15 U.S.C. ch. 63), establishing a technology transfer program within FAA to facilitate the transfer of scientific and technical information, data, facilities, and knowledge developed by FAA to the private sector or state and local governments. The order is not specifically directed at disseminating NextGen technology but rather, addresses general policy regarding FAA efforts to transfer the products, processes and services from FAA's research into the state and local government and private sectors. 15 U.S.C. § 3710.

⁹Pub. L. 108-176, § 709(a)(2)(G).

aspects of NextGen.¹⁰ (See fig. 1.) JPDO is also responsible for overseeing and coordinating NextGen research activities within the federal government and ensuring that new technologies are used to their fullest potential in aircraft and the air traffic control system. The memorandums of understanding among the partner agencies also require that the partner agencies have the mechanisms in place to coordinate and align their NextGen activities, including their NextGen-related budgets, acquisitions, and research and development. The legislation also directed the Secretary of Transportation to establish a Senior Policy Committee, to be chaired by the Secretary, to provide NextGen policy guidance and review, and to facilitate coordination and planning of NextGen by the partner agencies.

¹⁰JPDO identified the primary and supporting agencies for research, development, and other related activities in the NextGen Integrated Work Plan. The primary agency is expected to provide the overall ownership and leadership necessary to achieve the planning element. As many of the activities require the support, cooperation, and collaboration of multiple organizations, the supporting agency is expected to support the realization of the planning element through the provision of funds, staffing, facilities, intellectual capital, or other resources as needed. When it was first published, in September 2008, there was no formal agency concurrence on activity ownership. One of the key tasks of FY09 was to validate the content and ownership of each activity. According to the NextGen Integrated Work Plan, FAA has primary responsibility for 111 research and development activities and will support 72 additional activities—the most of any of the partner agencies.

Figure 1: Examples of Partner Agency Responsibilities for NextGen Technology Research and Development

	Advanced Aviation Operations and Safety
	<ul style="list-style-type: none"> • Applied research on advanced scheduling concepts in congested airspace • Applied research on effective surface management in various weather conditions
	Layered, Adaptive Security
	<ul style="list-style-type: none"> • Applied research on secure information exchanges at command and control facilities • Development of a common situational awareness capability
	Aeronautics Research and Technology
	<ul style="list-style-type: none"> • Applied research on air and ground-based air traffic management technologies for the entire gate-to-gate spectrum • Applied research on vehicle safety and future generation vehicles and propulsion systems
	Advanced Operations and Security
	<ul style="list-style-type: none"> • Applied research on net-centric stakeholder access to NextGen information • Applied research on certification methods, requirements, and standards for unmanned aircraft systems
	Weather Information Services
	<ul style="list-style-type: none"> • Applied research on the role of human forecasters and automated systems

Source: GAO analysis of JPDO information.

To help implement the responsibilities described in the legislation, each partner agency assigned a liaison to JPDO—as well as staff to JPDO in some cases. In addition, several working groups were created to facilitate collaboration between partner agencies and the private sector, and the NextGen Institute was created to be a forum for private industry involvement in NextGen planning and other activities. As initial NextGen planning was completed, and the focus turned to implementation, JPDO’s role has changed to focus on long-term research past 2018. Furthermore,

in 2010 a new JPDO Director was appointed (the office's fourth Director in its 7 years of existence) and JPDO was moved organizationally within FAA to raise its prominence within FAA and enable it to better serve as a mechanism for interagency collaboration.

Because NextGen implementation also requires expertise, research, and technology from the private sector, FAA has developed processes and mechanisms for interacting with the private sector. FAA views its Acquisition Management System (AMS) as the primary mechanism for transferring research and technology from the private sector. FAA's AMS establishes policy and guidance for all aspects of the acquisition lifecycle, and the AMS contracting process is designed to help FAA procure products and services from sources offering the best value to satisfy FAA's mission needs.

Some Mechanisms for Partner Agency Collaboration Are Effective, While Others Fail to Ensure Resources Are Being Leveraged

FAA and NASA Use a Variety of Mechanisms to Coordinate Research and Transfer Technology; Some Are Consistent with Key Practices in Interagency Coordination

FAA and NASA use research transition teams as a mechanism to coordinate research and transfer technologies and the design of these teams is consistent with several key practices of interagency coordination we have identified in previous work.¹¹ NASA has historically been FAA's primary source of long-term air traffic management research and continues to lead research and development activities for many key elements of NextGen. JPDO has identified NASA as the lead agency responsible for 55 of the 222 identified research and development activities needed to create the system and as a supporting agency in an additional 81 activities. In 2007 FAA and NASA, facilitated by JPDO,

¹¹See [GAO-06-15](#).

Research transition teams' technology products include:

- Concepts, technologies, and decision support tools to detect and resolve conflicts between aircraft on runways and taxiways.
- Decision support tools to handle the selection, assignment, and scheduling of aircraft to runways to simultaneously optimize operations across multiple airports.
- Definition and evaluation of proposed concepts and methodologies for determining optimal airspace allocation to balance demand, capacity, and controller workload.

created four research transition teams as mechanisms to transition the complicated technologies that do not fit within a single FAA office's purview under FAA's structure.¹² The teams cover approximately half of all research and development activities conducted by NASA's Airspace Systems Program—a group assigned to directly address fundamental NextGen needs. Each team addresses a specific issue area that (1) is considered a high priority, (2) has defined projects and deliverables, and (3) requires the coordination of multiple offices within FAA or NASA. Involving planning and operational personnel early is meant to avoid making decisions in isolation that may waste resources and time.

Consistent with key practices that can help enhance and sustain interagency collaboration, these teams identify common outcomes, establish a joint strategy to achieve that outcome, and define each agency's role and responsibilities, allowing FAA and NASA to overcome differences in agency missions, cultures, and established ways of doing business. Each research transition team develops and documents a plan that defines the scope of its efforts and the products to be developed. The plans outline a delivery schedule and the maturity level to which products will be developed. They also identify how products will be used by FAA in its investment decision process, describe what NASA will provide to FAA, and what FAA's involvement will be related to the conduct of research. For example, one team's plan includes development of a decision support tool to help manage the assignment and scheduling of runways at multiple airports to optimize operations. For this product, NASA is scheduled to deliver technical papers in 2012 and a software prototype in 2013. At the time of the scheduled transition to FAA in 2014, the tool should be at a prescribed level of technical maturity¹³ and FAA will make an implementation decision later that year.

Most of the four research transition teams have not yet delivered products and, while stakeholders are optimistic, whether technologies developed by these teams are ultimately implemented will largely depend on how well coordination occurs across multiple FAA offices involved in

¹²The four research transition teams are: Efficient Flow Into Congested Airspace, Integrated Arrival/Departure/Surface, Flow-Based Trajectory Management, and Dynamic Airspace Configuration.

¹³Technological maturity is measured by various levels of technology readiness. In this case, the tool should be at technology readiness level 4, which indicates that basic technological components are integrated in a laboratory environment to establish that the pieces will work together.

implementation. Research transition teams' products identified for development are expected to be transferred to FAA predominantly from 2012 through 2015. As of April 2011, NASA has delivered two final products¹⁴ and several interim informational products to FAA—including concept feasibility papers, an algorithm related to efficient flow in congested airspace, and data from a joint simulation. Going forward, stakeholders and participants with whom we spoke generally expressed optimism about the research transition teams' ability to transfer NASA work to FAA and into NAS. However, some stakeholders noted that success requires high-level commitment from each agency and effective team leads. Specifically, one NASA official noted that FAA's research transition team leads do not have the authority to make final decisions about the implementation of a given technology. Therefore, the success of the team's product will ultimately depend on that team lead's ability to work across various FAA offices to negotiate and coordinate a solution.

FAA and NASA also use other technology transfer mechanisms—including interagency agreements and test facility demonstrations—which have historically faced challenges at the point where the technology is handed off from NASA to FAA, but have nonetheless resulted in successful transfer and implementation of technology. Past technology transfer efforts between NASA and FAA faced challenges at the transfer point between invention and acquisition, referred to as the “valley of death.” At this point in the process, NASA has had limited funding at times to continue beyond fundamental research, but the technology was not matured to a level for FAA to assume the risks of investing in a technology that had not yet been demonstrated with a prototype or similar evidence. FAA and NASA officials have said the transition is still a challenge, but both are working to address this issue through interagency agreements that specify a commitment to a more advanced level of technological

¹⁴In March 2011, NASA delivered an investigation of the Multi-Sector Planner Concept for NextGen in the mid-term. A key research question for multi-sector trajectory planning operations was whether these operations could be integrated into the roles and responsibilities of current positions, or would require a new staffed position: the multi-sector planner. Simulation results showed effective multi-sector planning operations in both staffing conditions. The products delivered included results of these simulations as well as a concept for operational allocation of the multi-sector planner functions in an FAA facility. The products were delivered on time.

maturity of research than NASA has conducted at times in the past.¹⁵ Both interagency agreements and test facility demonstrations were used in the development and transfer of the Traffic Management Advisor, a program NASA developed, which uses graphical displays and alerts to increase situational awareness¹⁶ for air traffic controllers and traffic management coordinators. Through an interagency agreement, the two agencies established the necessary data feeds and two-way computer interfaces to support the program. NASA demonstrated the system's capabilities at the NextGen test facility in North Texas where it also conducted operational evaluations. NASA successfully transferred the program to FAA, which, after reengineering it for operational use, deployed it throughout the United States.

In some instances, the mechanisms FAA and NASA use to collaborate and transfer technologies have resulted in implementation of that technology in the NAS—as with Traffic Management Advisor; in others, the mechanisms have resulted in less tangible outcomes but nonetheless represent successful transfer in our view. For example, according to NASA officials, much of what is transferred between NASA and FAA is technical knowledge (e.g., an informational report or an algorithm) as opposed to a piece of hardware or new software. These products may not necessarily lead to immediate deployments, but the knowledge transferred may inform future decisions, lead to applied research, or be the precursors to future operational trials.

In other instances, these mechanisms may produce a proven technology that is ultimately not implemented by FAA, but can be successfully transferred to the private sector. For example, NASA developed a decision support tool intended to assist controllers in identifying the most optimal route given wind conditions.¹⁷ Though operational evaluation testing was

¹⁵In the past, NASA has focused on fundamental research and away from developmental work and demonstration projects. As a result, in some cases, NASA's research has focused on developing technologies to a lower—and therefore less readily adopted—maturity level. See GAO, *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).

¹⁶Situational awareness is related to accurately perceiving what is happening in the environment, thoroughly understanding the implications of what has been perceived, and the ability to project into the future.

¹⁷Aircraft in flight can reduce flying time and save fuel by flying routes that are more wind-favorable and direct than their current route.

successful, FAA chose not to pursue full-scale development of the capability because it ultimately did not consider the capability to be a controller function. However, Boeing has since leveraged NASA's work to develop Boeing Direct Routes, a service that uses advanced software algorithms to automatically alert an airline's operations centers and flight crew when a simple, more fuel-efficient path is available, permitting the operations center to propose those routes to FAA controllers for approval. Boeing predicts that the service will result in measurable decreases in aircraft fuel usage and emissions. In this case, even though FAA—NASA's intended customer—did not deploy the technology, it was successfully transferred to the private sector and will be used in the NAS to produce anticipated benefits consistent with NextGen goals.

FAA and Commerce Have Made Progress in Developing Mechanisms to Coordinate on Research and Transfer Technologies

FAA is primarily responsible for the air traffic management-weather integration process and for directing research and development of aviation-specific weather information and functionality.

NOAA is the lead for development and implementation of the weather database and will support FAA by providing weather interpretation and integration expertise.

DOD is expected to share weather-related developments, tool, methodologies, and data.

NASA is involved as a major developer of air traffic management tools and techniques, and weather integration methodologies.

Federal partners are also to involve the private sector in decisions that may affect them.

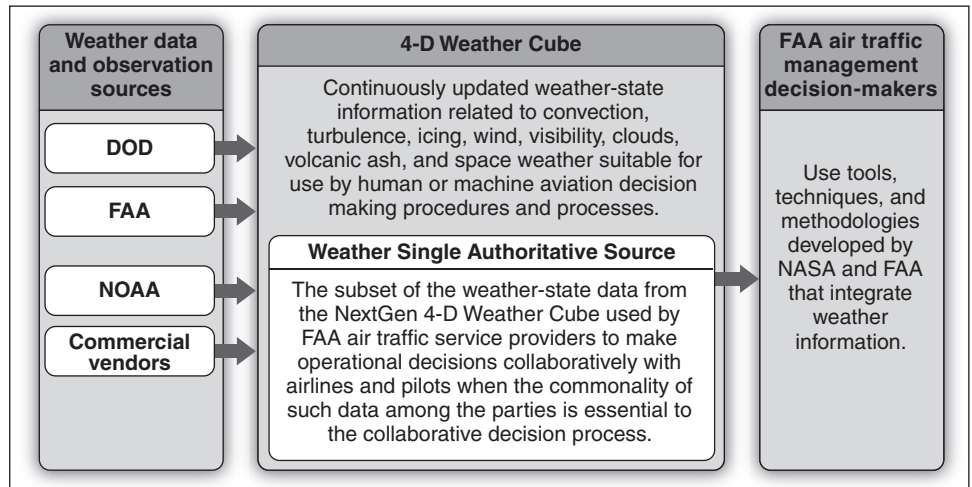
Commercial vendors can provide weather observations, analyses, and forecasts.

Collaboration between FAA and Commerce, specifically the National Oceanic and Atmospheric Administration (NOAA),¹⁸ has been facilitated by the creation of the NextGen Executive Weather Panel (the Executive Panel). Weather has a tremendous impact on aviation operations and accounts for approximately 70 percent of all air traffic delays. Assimilating weather information into air-traffic management decisions so that decision-makers can better identify areas where and when aircraft can fly safely is a key goal of NextGen. It also requires significant collaboration and coordination across agencies and the private sector to transfer the data, knowledge, and technology necessary. (See sidebar and fig. 2.)

In order to improve communication and coordination related to NextGen weather, the Senior Policy Committee approved the Executive Panel to act as the primary policy and decision-making body for NextGen weather issues. The Executive Panel is composed of high-level representatives from FAA, NOAA, DOD, NASA, and JPDO. According to one JPDO official, the Executive Panel is akin to the research transition team construct used by FAA and NASA in that it provides senior executive level oversight and coordination of interagency activities related to delivering NextGen weather capabilities. While the Executive Panel provides a forum for senior level direction, it has not connected researchers from NOAA with program and operation staff at FAA or identified specific technology development transition plans as the FAA and NASA teams have.

¹⁸Commerce, the agency under which NOAA is housed, is the agency with primary responsibility for eight research and development activities. JPDO has recommended that Commerce provide support for 19 additional activities.

Figure 2: Partner Agency and Private-Sector Involvement in Weather Technologies



Source: GAO analysis of FAA, JPDO, and NOAA information.

Progress is also being made in defining each agency's roles and responsibilities, though this task has not been completed. For instance, FAA and NOAA have a memorandum of understanding from 2004 that generally establishes the responsibilities of each agency for meeting aviation weather requirements, and in 2010, the agencies jointly completed an integrated management plan for NextGen Network-Enabled Weather and the NextGen 4-D Weather Data Cube. In addition, the two have come to agreements on financial responsibility for some weather projects. For example, FAA and Commerce have come to an overall agreement that the National Weather Service will fund the development of the NextGen 4-D Weather Data Cube and FAA will fund the development of the NextGen Network-Enabled Weather capability, which is expected to connect to the Cube for weather data. There is also agreement that funding for any research and development or capabilities that are aviation unique (e.g., turbulence forecasting) would need to be negotiated between the two agencies. However, FAA and Commerce have not developed an overarching strategy that would identify those specific capabilities in advance. Development of a research management plan is one step expected to facilitate the process to meet NextGen weather needs by the partner agencies, clarify roles and responsibilities, and improve the process for transitioning FAA weather research into National Weather Service operations. Similar to other agencies, any lack of coordination between FAA and Commerce could result in duplicative research and inefficient use of resources at both agencies.

FAA and Commerce use additional mechanisms to coordinate their research and have transitioned some weather technology. For instance, FAA, NOAA, and NASA have held joint research program reviews in each of the last 2 years to enhance collaboration and identify duplications in efforts, according to FAA. Researchers from several of NOAA laboratories and forecast centers have also collaborated with FAA in research planning, development, and assessment as well as implementation of research results through interagency agreements. According to NOAA officials, it has worked with FAA to coordinate and align program goals and requirements to meet NextGen weather needs and in the last 2 years, FAA transitioned two weather technologies to NOAA's National Weather Service.¹⁹ In addition, a team from FAA and NOAA's National Weather Service, sponsored by JPDO, has begun to develop the functional requirements for NextGen aviation weather systems and continue to work together on additional weather-related planning efforts.

Mechanisms for Collaborating on Research and Technology Development Efforts with DOD and DHS Do Not Ensure That Resources Are Fully Leveraged

FAA and DOD Mechanisms Have Yet to Fully Determine What Research, Technology, or Expertise DOD Has to Support NextGen Activities

DOD has not completed an inventory of its research and development portfolio related to NextGen, impeding FAA's ability to identify and leverage potentially useful research, technology, or expertise from DOD. JPDO has recommended that DOD have primary responsibility for 6 research and development activities and provide support for an additional 47. In December 2007, DOD designated the Air Force as the lead service for the agency's NextGen involvement, and, in the formal agreement that established roles and responsibilities for JPDO and the partner agencies, DOD agreed to develop mechanisms to align its NextGen-related research

¹⁹The two technologies are: (1) the Graphical Turbulence Guidance-2, which provides clear air turbulence forecasts above 10,000 feet updated hourly out to 12 hours, and (2) the Forecast Icing Product, which provides probabilistic forecasts of in flight icing as well as severity and supercooled large drop potential. Both technologies were developed by the National Center for Atmospheric Research with FAA funding.

and development efforts with JPDO's Integrated Work Plan. Air Force officials expected to have completed a comprehensive list of DOD's NextGen-related research and development activities and programs, as well as a roadmap to facilitate technology transfer by November 2009. In June 2010, the DOT Office of the Inspector General recommended that FAA develop a plan to identify research and technologies from DOD's research and development portfolio that could be used for NextGen and establish a mechanism to coordinate and transfer that information to the appropriate FAA program or development offices.²⁰ According to JPDO, it has established contacts with various DOD organizations, but has only begun to develop a plan to review and identify DOD research and technologies potentially useful for NextGen. As of March 2011, DOD had compiled a preliminary but incomplete list of its NextGen-related research and development. According to DOD officials, the office underestimated the size and complexity of the task. As a result of progress made during 2010 and 2011, it has become clear that the original tasking was not the ideal approach. Instead, DOD plans to form technical teams with representatives from the research and development bodies within each agency to identify critical NextGen research and development needs and using that list of specific needs, identify programs that may address them. This process is currently being applied to the area of unmanned aircraft systems in an interagency effort led by JPDO.

At the same time, DOD's ability to identify potentially useful research and technology may be impeded by FAA's inability to identify the scope of its needs. Though JPDO has identified the research and development activities needed to deliver NextGen, according to DOD officials, FAA has not provided, in some cases, enough specificity of its NextGen technological gaps, so that DOD can help identify where its research and development efforts and expertise may provide benefit. As we have previously reported, a key aspect of successful agency coordination is identifying and addressing needs by leveraging resources. Collaborating agencies can accomplish this by identifying the human, information technology, and physical and financial resources needed to initiate or sustain their collaborative effort. However, without an inventory, DOD, JPDO, and FAA have been unable to identify all the resources at DOD that may be useful for NextGen, or the budgetary resources that DOD puts

²⁰Department of Transportation Inspector General, *Timely Actions Needed to Advance the Next Generation Air Transportation System*, AV-2010-068 (June 16, 2010).

toward NextGen-related activities.²¹ Lack of coordination between FAA and DOD could result in duplicative research and inefficient use of resources at both agencies.

Although DOD has liaisons at FAA and JPDO, according to DOD and JPDO officials, communication challenges continue to impede coordination and collaboration between the agencies. DOD has assigned a liaison to JPDO with experience in net-centric operations, one of the areas in which stakeholders view DOD expertise as an important contribution to NextGen. DOD also co-chairs JPDO's Net-Centric Operations Working Group and contributes as a member of various other JPDO committees, boards, and working groups. In addition, in 2010 DOD assigned a liaison from the Air Force Research Laboratory to FAA's NextGen and Operations Planning, Research and Technology Development Office to act as a conduit into DOD's research base. We have previously reported that as agencies bring diverse cultures to collaborative efforts, it is important to address those differences in a way that will enable a cohesive working relationship and create the mutual trust required to enhance and sustain such a collaborative effort. In particular, according to DOD officials, differences in terminology and culture across agencies create communication challenges between FAA and DOD. DOD research plans were developed according to DOD needs, using DOD's terminology, not with potential connection to NextGen and civil aviation in mind. To understand the extent to which DOD research can address NextGen needs, DOD officials stated that subject matter experts from both FAA and DOD with extensive knowledge of DOD research and NextGen would need to review the existing research, determine what connections exist to NextGen plans, and develop a method of communicating and translating how DOD research supports NextGen activities. Existing mechanisms for collaboration between FAA and DOD are not currently designed or equipped to accomplish this task.

²¹In 2006 we recommended that JPDO identify NextGen-related programs in the partner agencies' budgets and consolidate that information in one budget document to help FAA, JPDO, and Congress track partner agencies' involvement in NextGen, determine whether funding is adequate for specific efforts, and track the overall cost of NextGen. See 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). While JPDO has received information from Commerce and NASA, as of June 2011, DOD and DHS have been unable to provide JPDO with budgetary figures on their NextGen activities.

DHS's Collaboration with FAA and JPDO on NextGen Has Been Limited in Certain Areas of NextGen Research, and the Agencies Have Yet to Fully Determine What Can Be Leveraged to Support NextGen

DHS's collaboration is important in several areas of NextGen research, particularly related to unmanned aircraft systems and cyber security; however, thus far, DHS's participation has been limited in these key areas. DHS plans to use unmanned aircraft systems to monitor the nation's borders and plays a key role in the initiative to safeguard federal government systems from cyber threats and attacks, including conducting and coordinating cyber security research and development. DHS has collaborated with the partner agencies on NextGen as the co-chair of JPDO's Aviation Security Working Group, one of nine working groups that JPDO established to solve problems and make fact-based recommendations to be integrated into NextGen. According to DHS officials, it helped develop the security component of NextGen planning and has been an active participant, since JPDO's inception, through the working group it co-chairs. DHS has also been involved in NextGen integrated surveillance planning and coordination efforts in collaboration with FAA and DOD. Though these are steps toward identifying common outcomes and joint strategies, in other important areas DHS has had limited participation in NextGen. JPDO has recommended that DHS be the agency with primary responsibility for 19 research and development activities and provide support for an additional 18. Many of the activities for which DHS is primarily responsible are related to baggage screening and other security functions, not air traffic management functions where FAA would be the implementer. However, like DOD, DHS has not identified and aligned its NextGen-related research and development activities as it agreed to do in the formal agreement that established the roles and responsibilities of JPDO and the partner agencies, and has not identified the budget figures associated with NextGen activities. In addition, according to DHS officials and other partner agencies, DHS was not involved in early planning for activities at JPDO specifically related to cyber security. DHS officials commented that sometimes DHS does not participate in events either because it is not invited or because it does not choose to participate. Limited collaboration between DHS and FAA could result in conflicts in NextGen priorities and needs in the future. As we have previously reported, that lack of collaboration can result in marginalizing NextGen areas that affect DHS.²² Further, given DHS's responsibility for cyber security, lack of coordination in this area could result in FAA not fully leveraging technologies developed by DHS.

²²GAO, *Next Generation Air Transportation System: Challenges with Partner Agency and FAA Coordination Continue, and Efforts to Integrate Near-, Mid-, and Long-term Activities Are Ongoing*, [GAO-10-649T](#) (Washington, D.C.: Apr. 21, 2010).

DHS and JPDO collaboration efforts may improve with the assignment of a new executive representative. In October 2010 DHS's executive representative to JPDO left the agency, and DHS did not initially identify a replacement. According to one JPDO official, participation in work on integrated surveillance began to lag at that point, although according to DHS, its efforts through JPDO's Aviation Security Working Group continued. DHS assigned a new executive representative and back-up in January 2011 and integrated surveillance work has resumed.

FAA and Partner Agencies Are Working to Address Research Gaps

FAA and partner agencies are working to address previously identified research gaps, though coordination is an issue in some areas. In 2008 JPDO conducted a cross-agency gap analysis intended to identify major differences between NextGen planning documents and partner agency plans and budgets. JPDO identified gaps in key research and implementation focus areas that are critical to NextGen and involved joint agency missions and expenditures. The areas where gaps were identified included unmanned aircraft systems, human factors, and airspace security. According to FAA's chief scientist for NextGen development, efforts are underway in each of these areas. For instance, FAA, in partnership with JPDO, and the partner agencies are defining the research and development needs for operating unmanned aircraft systems in domestic airspace and are developing a joint concept of operations and research roadmap. In late 2010, JPDO sponsored a workshop on unmanned aircraft systems that brought together subject-matter experts and executives from FAA, JPDO, DOD, and NASA. The workshop focused on critical and cross cutting long-term research and development issues and was a step toward JPDO's goal of having the technologies, procedures, standards, and policies in place to achieve full integration of unmanned aircraft systems. However, DHS, which will be one of the primary operators of these systems in domestic airspace, did not participate. A lack of coordination could result in a duplication of research or an inefficient use of resources.

With regard to human factors, as we have previously reported, FAA and NASA are coordinating their NextGen human factors research using a variety of mechanisms—including research advisory committees, interagency agreements, and research transition teams. In addition, FAA has also created a human factors portfolio to identify and address priority human factors issues. In addition, in February 2011, FAA and NASA completed a cross-agency human factors plan as JPDO and we recommended. Finally, with respect to airspace security, according to FAA, it is engaging with both DOD and DHS through JPDO sponsored events. However, FAA is unable to move forward with some of its airspace

security research and development because DHS has not involved the appropriate personnel needed to move the issue area beyond the concept development phase.

**Numerous
Mechanisms Are
Available to
Collaborate with
Industry and to
Identify and Transfer
Technology, but Some
Lack Flexibility and
Outcomes Can Be
Unclear**

**FAA's Acquisition
Management System
Provides a Framework for
Technology Identification,
Development, and
Transfer, but Can Lack
Flexibility**

Broadly speaking, FAA's Acquisition Management System (AMS) provides a framework for FAA to undertake research and development of concepts and technologies, progress that technology to a point where FAA can define the requirements to meet its needs, and then either identify existing technology that meets those needs or request proposals from industry to develop the technology.²³ Within the AMS, FAA may use several mechanisms at various stages to conduct outreach, collaborate with private sector firms, and transfer technology. (See table 1.) In particular, FAA may use several types of research and development agreements between itself and the private sector as mechanisms to facilitate technology transfer. These agreements include cooperative research and development agreements, memorandums of agreement, memorandums of understanding, and other transaction authority. Cooperative research and development agreements allow FAA to share facilities, equipment, services, or other resources with private industry, academia, or state and

²³We have found issues in the past with how FAA manages its acquisitions, particularly with regard to ensuring adherence to cost and schedule. GAO has open recommendations in this area to FAA and is currently undertaking a review of specific FAA acquisitions.

local government agencies and are part of meeting FAA’s technology transfer program requirements.²⁴ Within FAA’s Research and Technology Development Office, as of January 6, 2011, there are over 20 such agreements with industry or academia.²⁵ Prior to pursuing an acquisition, the agency is required under the AMS to conduct a market analysis to determine if the needed capability exists in the marketplace or has to be obtained through the acquisition process. A market analysis may be conducted as FAA moves forward with an acquisition. FAA may publicly request proposals from private industry to develop the technology, and any private sector entity can submit its proposal for meeting FAA’s requirements and compete against other entities for the contract award.

Table 1: Examples of Mechanisms to Facilitate Technology Transfer That May Be Used within Selected AMS Phases

AMS Phase	Examples of Mechanisms Used to Facilitate Technology Transfer That May Be Used in This Phase
Service Analysis —determines what capabilities must be in place now and in the future to meet agency goals and the needs of customers.	Industry days, symposiums, technical interchange meetings, interagency agreements, cooperative research and development agreements, memorandums of agreement, requirement setting, prototype demonstrations, SE 2020 contract, NextGen Institute
Concept and Requirements Definition —involves FAA undertaking research or using research by other agencies or industry to define an operational concept, develop preliminary requirements, or achieve customer buy-in to potential solutions to mission need.	Cooperative research and development agreements, memorandums of agreement, requirement setting, prototyping, demonstrations, operational trials at test facilities, SE 2020 contract, NextGen Institute
Initial Investment Analysis —designed to provide information to decision makers to select the best technological alternative that meets the required performance and offers the greatest value.	Market research analysis, industry days, requirement setting, prototyping, demonstrations, and operational trials at test facilities

²⁴FAA Order 9550.6A, Technology Transfer Program, sets forth these requirements.

²⁵FAA’s Research and Technology Development Office manages FAA’s research, engineering & development program to assure alignment with FAA planning documentation, coordinates aviation research with international organizations worldwide, and identifies, executes, and manages research and development projects related to existing and new technologies and procedures consistent with FAA’s mission.

AMS Phase	Examples of Mechanisms Used to Facilitate Technology Transfer That May Be Used in This Phase
Final Investment Analysis —provides detailed planning for the technological alternative selected for implementation.	Market research analysis, industry days, requirement setting, prototyping, demonstrations, and operational trials at test facilities

Source: GAO analysis of FAA information.

Note: Many of the mechanisms listed occur in multiple AMS phases.

However, under some circumstances, stakeholders said that AMS can lack flexibility for FAA to consider alternative technologies or new ideas for certain technologies or sub-systems within an acquisition once the process is underway. According to several industry stakeholders we spoke with, if they have a technology they believe is worth considering to improve some aspect or meet some need of a system that is being developed at FAA—such as a piece of software or some data that may be relevant to improve decision-making—there is no clear entry gate for getting that technology considered. Other stakeholders said that FAA has difficulty considering technologies that cut across programs and offices, and one stakeholder said that such ideas may not be considered because there is no clear “home” or “champion” within FAA for the technology. Similar issues have been encountered for technologies that NASA developed, which resulted in the creation of the research transition teams discussed previously. In the past, we have recommended that FAA improve its ability to manage portfolios of capabilities across program offices.²⁶ However, on the other hand, at a certain point, FAA must be able to commit resources, finalize plans, and stop considering alternatives in order to move forward with implementing a new system. Furthermore, according to these officials, once FAA makes a decision to pursue a particular technological path, it can become costly to change course; therefore, any benefits of changing course must be weighed against the costs. Nonetheless, industry stakeholders suggested that additional avenues to consider alternative technologies could be made available and could result in technologies that

²⁶GAO, *NextGen Air Transportation System: FAA’s Metrics Can Be Used to Report on Status of Individual Programs, but Not of Overall NextGen Implementation or Outcomes*, [GAO-10-629](#) (Washington, D.C.: July 27, 2010).

enable FAA to meet its mission more efficiently. We have made recommendations to FAA over the years to improve its AMS process.²⁷

To address this issue at least in part, FAA has recently designed another contracting tool to provide it with research and development and systems engineering support to integrate NextGen concepts, procedures and technologies into the NAS, which may provide some additional flexibility for collaboration and technology transfer with industry. The Systems Engineering 2020 (SE 2020) contracts are a set of multiple award, up to 10-year umbrella contracts worth approximately \$6.4 billion. Under SE 2020, FAA will be able to have participating firms support NextGen implementation activities such as concept exploration, modeling and simulation, and prototype development. By pooling engineering expertise under a single contracting vehicle, FAA believes it will be able to more quickly obligate funds and issue task orders, which is intended to result in implementing NextGen more quickly. FAA officials believe that this process, by structuring the umbrella contract to include small businesses, would encourage the participation of more small businesses in its efforts to implement NextGen. Firms that have not been selected will not be able to participate in the SE 2020 program.²⁸ However, according to some industry officials, the program's ability to more quickly obligate funds and issue and complete task orders has yet to be fully demonstrated, and stakeholders we spoke with expressed concerns about whether FAA's efforts to expedite the work will mean missing out on the expertise of excluded companies.

FAA also has an unsolicited proposal evaluation process that is designed as a mechanism for private industry to offer unique ideas or approaches outside FAA's competitive procurement process; however, it has not proven to be a significant source of new technology for FAA. From 2008 to 2010, FAA received 56 unsolicited proposals from private industry and rejected all but one of them. The most common reasons for rejection, according to FAA, were that the proposals were not unique and innovative or that FAA already had an effort in place to meet that requirement. (See table 2.) In general, we found that FAA's reasons for rejecting proposals

²⁷ 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).

²⁸ About 90 pre-approved companies are participating on the vendor teams, including air framers, avionics manufacturers, and system developers and integrators.

met FAA’s established criteria for evaluating unsolicited proposals. However, FAA evaluators told us that FAA’s “unique and innovative” criterion for an unsolicited proposal was a difficult criterion to meet for proposals, because technologies often build on previous technologies. Furthermore, if a firm submitting an unsolicited proposal is to receive a sole source contract, competitive procurement principles require that it must be found that no other company can provide the technology but the company submitting the unsolicited proposal. If this is not the case, competitive proposals must be sought. Some participants told us that technologies should not be eliminated from consideration even if their application is not entirely unique and contracts to implement them might have to be awarded competitively. FAA evaluators commented that there was little guidance on how to interpret the criteria, including the unique and innovative criterion in particular, for evaluating unsolicited proposals. Some suggested that additional guidance on applying criteria or a review panel could be set up to assist in reviewing the ideas contained in these proposals.

Table 2: FAA’s Four Most Commonly Provided Reasons for Not Accepting Unsolicited Proposals

Reason for non-acceptance provided by FAA	2008 Reasons provided	2009 Reasons provided	2010 Reasons provided	Total
Not unique or innovative	6	10	2	18
The requirement has already been met or is being met	4	5	2	11
FAA does not have a requirement at this time	3	2	3	8
Does not meet FAA’s mission	3	2	2	7

Source: GAO analysis of FAA data.

Note: Sometimes FAA provided multiple reasons for the rejection of a proposal.

Participants also told us that the process, in some cases, is not collaborative, which may hinder FAA from leveraging potentially valuable technologies. Other participants explained that FAA’s written response sometimes did not reflect a full understanding of what a company was offering, so in these cases the companies would have liked an opportunity to clarify the merits of their proposal. Although FAA says that companies whose proposals are rejected can meet with the program offices to discuss reasons for rejection, some companies told us this opportunity was not always provided. Where there are disagreements between FAA and companies submitting unsolicited proposals over FAA’s stated reason for

rejection of a proposal, FAA is not required to discuss why a submission was rejected or how it might be improved.

FAA's Mechanisms for Industry Collaboration Can Enhance Knowledge and Lead to Transferring Technology, but Outcomes Are Not Always Clear

Outreach Events with Private Industry

FAA conducts various outreach events with its research stakeholders, including those in industry, to exchange information among stakeholders currently engaged in collaborative technology projects and to communicate NextGen's direction to potential collaborators. From 2008 through 2010, over 300 outreach events were held during which FAA presented technical information focused on planned or on-going NextGen projects and programs. Seminars, conferences, and industry days are designed to inform industry about where FAA is headed with regard to NextGen and any changes that may have occurred in NextGen's direction in the last year. The identification of technologies for use in NextGen is not necessarily a goal of many of these efforts. Although technology identification or transfer may not occur at these events, they can create and reinforce working and personal relationships between leading experts and researchers in the air traffic management research and development community, create opportunities to share available research results, and maintain consensus between FAA and industry on major issues.

Some FAA and industry events, however, have had more of a collaborative purpose, creating opportunities for information and technical exchanges. Technical interchange meetings, workshops, and demos are designed to address select technical issues and have been used to try and identify existing technologies or to communicate to private sector stakeholders specific technological or research needs that they can address. These meetings can result in the identification of existing technologies that can be used by FAA to meet a specific need. For example, FAA's Global Navigation Satellite System Program Office recently sponsored a workshop for a broad range of industry and partner agency stakeholders to come together to discuss needs and potential solutions for a back-up system that could support the Global Positioning System if satellites became unavailable. The purpose of the workshop was to collaboratively work with partner agencies and industry to identify existing technologies

and systems that can be modified to provide a viable backup system. One industry participant we spoke with told us that the workshop was highly collaborative and had positive results in terms of focusing on technology that could be leveraged by FAA. However, according to participants in other events, it is often unclear what happens after these events in terms of taking the next steps to transfer knowledge or technology or working with FAA to develop solutions. FAA keeps documentation of what occurs at these meetings, including information on outcomes from the event. Our review of this documentation found that few events documented concrete outcomes or identified next steps to further develop ideas or technologies identified and discussed at an event.

NextGen Institute

JPDO is reassessing the role and structure of the NextGen Institute as a mechanism for collaboration and technology transfer with industry. The DOT Inspector General recommended in June 2010 that JPDO determine whether there is a continued need for the Institute and, if there is, to redefine its roles and responsibilities to avoid duplication with other private-sector organizations. The NextGen Institute was established in March 2005 as the mechanism through which JPDO would access private-sector expertise in a fair and balanced framework that embraces all individuals, industry, and user segments for application to NextGen activities and tasks. However, participation in the Institute diminished over time as funding was uncertain. Recently, a new Executive Director was named for the Institute, and the JPDO is working closely with the new Executive Director and the Institute Management Council—which oversees the policy, recommendations, and products of the NextGen Institute—to identify a course of action that is embraced by industry stakeholders. According to several private-sector stakeholders we spoke with, the NextGen Institute could serve as a valuable mechanism for FAA and industry collaboration if properly designed and structured.

RTCA Efforts

While not necessarily a technology transfer mechanism, RTCA—a private, not-for-profit corporation that develops consensus-based recommendations within the aviation community on communications, navigation, surveillance, and air traffic management system issues—is a key source of FAA and industry collaboration. For example, in 2009 RTCA convened the NextGen Midterm Implementation Task Force at the request of FAA, which brought together key stakeholders in the aviation community. The Task Force reached a consensus within the aviation community to focus on implementing capabilities in the NAS that take advantage of existing technologies and capabilities aboard aircraft. In addition, RTCA has recently created the NextGen Advisory Committee, which is comprised of top-level executives representing various parts of

FAA's NextGen Test and Research Facilities

the aviation and aerospace industries, as well as airports, air traffic management, and various other public and private stakeholder groups.

Some NextGen test facilities serve as a forum in which private companies may learn and partner with each other, and eventually, enter into technology acquisition agreements with FAA with reduced risk. The FAA Technical Center test facility in Atlantic City, New Jersey, and the Embry Riddle test facility in Daytona, Florida, provide places where integration and testing with industry can take place without affecting day-to-day air traffic operations. They also enable industry and government to ensure that new technologies will integrate with systems currently in the NAS and, according to a senior FAA official, allows FAA to leverage private sector funding, expertise, and technologies. For example, in November 2008, several companies, including Lockheed Martin and Boeing, were involved in an FAA demonstration at Embry Riddle on how current and forecasted weather information can be integrated into FAA's traffic management and en route automation systems. Also at Embry Riddle, Lockheed Martin is funding some work in conjunction with US Airways on a new time-based traffic flow management system designed to provide increased gate-to-gate air traffic predictability.

The success of these test facilities as opportunities to leverage private-sector resources depends in large part on the extent to which the private sector perceives benefits to their participation. Representatives of firms participating in test facility activities told us that tangible results in terms of implementation of technologies developed were important to maintain private sector interest and that it was not always clear what happened to technologies that were successfully tested at these sites. In June 2010, the DOT Inspector General also reported that demonstrations may not provide a clear path to implementation and are sometimes not outcome-focused. We have also reported that FAA should increase its focus on performance and outcomes.²⁹ One of the difficulties cited by officials at these test facilities was that if a technology being tested did not have a place in one of the NAS Enterprise Architecture Infrastructure Roadmaps,³⁰ then there was no implementation plan for that technology and no next steps to get that technology into the NAS. For example, NASA was developing the Precision Departure Release Capability, a software technology that links

²⁹See [GAO-10-629](#).

³⁰NAS Enterprise Architecture Infrastructure Roadmaps describe the transition strategy for the NAS from the as-is to the to-be environment.

Traffic Management Advisor to other information to better plan flight departures by minimizing delays once passengers have boarded the plane. This technology, however, was not a capability or technology that was a part of the Enterprise Architecture Roadmap, and NASA had difficulty finding support for it, its merit and FAA's interest in pursuing it notwithstanding. According to NASA officials that worked on the capability, the process for getting a technology into a roadmap was not transparent to participants at the test facilities and it took considerable time and effort to eventually get the capability included in the roadmap and garner support.

To advance aviation partnerships and the development and transfer of aviation technologies, the concept for a Next Generation Aviation Research and Technology Park was developed through a collaborative effort by local, county, state, and federal agencies; academia; and private sector interests. As a result of this effort, the FAA entered into a lease and memorandum of understanding with the South Jersey Economic Development District to build a Next Generation Research and Technology Park adjacent to the William J. Hughes Technical Center near Atlantic City, N.J. The lease transfers control of 58 acres of FAA property for construction of the complex. The Park is a partnership that is intended to engage industry in a broad spectrum of research projects, with access to state-of-the-art federal laboratories. The establishment of this park will help encourage the transfer of scientific and technical information, data, and know-how to the private sector and is consistent with FAA's technology transfer program order. The park will offer a central location for the FAA's industry partners to perform research, development, testing, integration and verification of the technologies, concepts, and procedures required by NextGen. According to FAA, this private-sector engagement in research has the potential to save significant time and expense in bringing new products to market and reducing the time to deliver NextGen components. The Park is intended to complement the NextGen demonstration capabilities at Embry Riddle Aeronautics University in Daytona, Florida. Advanced NextGen technologies developed and tested at the Technical Center will be demonstrated in an operational environment at Daytona then returned to the Technical Center for integration with the current NAS and other components of NextGen.

Conclusions

Transforming the nation's air transportation system is a technically complex undertaking that will affect FAA's activities and missions, and those of federal partner agencies and the private sector. NextGen's success is dependent, in significant part, on FAA's ability to leverage the

research and technology efforts of these agencies and firms. While much has been done to develop mechanisms for effective research and technology transfer, some mechanisms have not been successful in ensuring that FAA is leveraging the research and technologies of its partners. In particular, FAA and DOD have yet to completely identify DOD's potentially beneficial research and technology. In addition, FAA and DHS's collaboration in identifying areas for joint research and technology development is limited.

Effective transfer of research and technology requires effective collaboration, and we have previously found that interagency collaboration is enhanced when agencies, among other things, define common outcomes, identify and address needs, establish joint strategies, agree on roles and responsibilities, and establish compatible policies, procedures and other means to operate across agency boundaries. FAA's collaborative mechanisms with DOD and DHS fall short of fulfilling these criteria. FAA's ability to identify potentially useful DOD and DHS research and technology has been impeded because DOD and DHS have not completely identified research and development in their portfolios that is applicable to NextGen, while DOD's ability to identify potentially useful research and technology may be impeded because FAA has not made clear the scope of its needs with enough specificity. Further, communication between DOD and FAA has been hampered by differing vocabularies and terms, and mechanisms have not yet been developed to help the agencies work across agency boundaries. While we have noted these issues in several reports over the years and the DOT Inspector General has made recommendations for FAA to develop a plan to review DOD's research, we find that much remains to be done in this area to improve the communication and collaboration between the agencies. Unless FAA and its partner agencies communicate and jointly identify ongoing research and technology development that is relevant to NextGen efforts, FAA will not be able to fully leverage the potential of its partner agencies' research and technology development efforts.

In this report, as well as in a previous report, we note that FAA and its partner agencies have struggled to develop an integrated budget document that tracks partner agencies' involvement in NextGen, determines whether funding is adequate for specific efforts, and tracks the overall cost of NextGen. Failure to complete this effort makes it difficult for FAA and the Congress to understand the extent to which FAA is leveraging the research efforts of its partners to achieve the NextGen vision. We have an open recommendation to FAA with regard to developing this integrated budget

and are monitoring actions related to our recommendation. We are therefore not making recommendations in this report about this issue.

We also discuss several issues throughout the report with respect to how FAA collaborates with the private sector to transfer research and technology. For example, while FAA conducts market analysis, holds numerous events with industry, enters into various collaborative agreements, and has numerous mechanisms—such as the NextGen Institute, demonstrations, and testing facilities—to collaborate with industry and provide opportunities for technology transfer, it is not always clear what comes out of these mechanisms, and some in industry have indicated that, despite all of these collaborative activities, it is not always evident what are the “entry points” to FAA for getting technologies or ideas considered. Nonetheless, numerous mechanisms exist, and additional mechanisms are being reconsidered, or are still under development, such as the NextGen Institute and the Research and Technology Park. We also found that FAA’s AMS process can limit FAA’s ability to consider alternatives in some cases, and that FAA has difficulty considering technology solutions that cut across several programs or offices at FAA. We have made several recommendations to FAA over the years to address these issues. We have recommended that FAA improve its AMS process, improve its ability to manage portfolios of capabilities across program offices, and increase its focus on performance and outcomes, which FAA has begun to implement. Moreover, the DOT Inspector General made a recommendation in 2010 for FAA to reassess the current role and continued need for the NextGen Institute and to ensure that it is a useful resource and not duplicative with other mechanisms designed to work with private industry. We are therefore not making any further recommendations to FAA in these areas, but encourage FAA to continue its efforts to address existing recommendations.

Recommendation for Executive Action

To more fully leverage the potential of NextGen partner agencies’ research and technology development efforts, we recommend that the Secretary of Transportation direct the Administrator of the FAA to work with the Secretaries of Defense and Homeland Security to develop mechanisms that will further clarify NextGen interagency collaborative priorities and enhance technology transfer between the agencies. These mechanisms should focus on improving interagency communication about the specific needs, outcomes, and existing research that FAA has for NextGen, and the existing research and technology development portfolios that may be applicable to NextGen within DOD and DHS. These mechanisms should aim to improve the ability of the agencies to leverage resources or transfer

knowledge or technology among each other consistent with the key practices for successful collaboration that we lay out in this report.

Agency Comments and Our Evaluation

We provided a draft of this report to the Departments of Transportation, Defense, Homeland Security, and Commerce, NASA, and the Office of Science and Technology Policy. The Department of Transportation provided technical comments by e-mail, which we incorporated as appropriate, but did not comment whether or not it agreed with our recommendation. The Department of Defense provided written comments, which are reproduced in appendix I. DOD concurred with our recommendation and highlighted the existing mechanisms it has that support agency collaboration and technology transfer. The Department of Homeland Security provided written comments, which are reproduced in appendix II. DHS also concurred with our recommendation and mentioned a newly formed mechanism—the Air Domain Awareness Board—that will support technology transfer discussions among DHS, FAA, JPDO, and other stakeholders in relation to NextGen. These mechanisms are positive steps toward NextGen technology transfer among the partner agencies. However, as our recommendation further states, DOD and DHS should ensure that relevant research and development activities that could support NextGen are identified within these or other mechanisms, and that appropriate steps are taken to develop mechanisms to effectively transfer any identified research and technology. Because the mechanisms DOD and DHS identified have not yet demonstrated these results, we believe that fully implementing the recommendation is still important beyond the existing mechanisms used by DOD and DHS. The Office of Science and Technology Policy provided one technical comment by e-mail, which we incorporated. The Department of Commerce and NASA had no comments.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 7 days from the report date. At that time, we will send copies of this report to interested congressional committees, the Secretary of Transportation, the Administrator of the Federal Aviation Administration, NASA, DOD, DHS, Commerce, the Office of Science and Technology Policy, and other parties. In addition, the report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

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

A handwritten signature in black ink that reads "Gerald Dillingham". The signature is written in a cursive, flowing style.

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

Appendix I: Comments from the Department of Defense



RESEARCH
AND ENGINEERING

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3030 DEFENSE PENTAGON
WASHINGTON, DC 20301-3030

JUN 29 2011

Mr. Gerald L. Dillingham
Director, Physical Infrastructure Issues
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Dillingham:

This is the Department of Defense (DoD) response to the GAO draft report GAO-11-604, "NEXTGEN AIR TRANSPORTATION SYSTEM: MECHANISMS FOR COLLABORATION AND TECHNOLOGY TRANSFER COULD BE FURTHER ENHANCED TO MORE FULLY LEVERAGE PARTNER AGENCY AND INDUSTRY RESOURCES," dated June 30, 2011, (GAO Code 540215). Detailed comments on the report recommendations are enclosed.

The Department has reviewed the draft report and concurs with the draft report, and indicated two actions, which will form the fundamental framework of a mechanism to improve interagency communication between the DoD and FAA for Research Technology Transfer.

Sincerely,

Stephen P. Welby
Deputy Assistant Secretary of Defense
Systems Engineering

Enclosure:
As stated

GAO Draft Report Dated June 8, 2011
GAO-11-604 (GAO CODE 540215)

**“NEXTGEN AIR TRANSPORTATION SYSTEM: MECHANISMS FOR
COLLABORATION AND TECHNOLOGY TRANSFER COULD BE FURTHER
ENHANCED TO MORE FULLY LEVERAGE PARTNER AGENCY AND INDUSTRY
RESOURCES”**

**DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATIONS**

RECOMMENDATION: To more fully leverage the potential of NextGen partner agencies' research and technology development efforts, GAO recommends that the Administrator of the FAA and the Secretaries of Defense and Homeland Security work together to develop mechanisms that will enhance technology transfer between the agencies. These mechanisms should focus on improving interagency communication about the specific needs, outcomes, and existing research that FAA has for NextGen, and the existing research and technology development portfolios that may be applicable to NextGen within DOD and DHS. These mechanisms should aim to improve the ability of the agencies to leverage resources or transfer knowledge or technology among each other consistent with the key practices for successful collaboration that GAO lays out in this report. (See page 31/GAO Draft Report.)

DoD RESPONSE:

As DoD's lead Service for the NextGen effort, the Air Force reviewed the GAO report on NextGen Air Transportation System and concurs with the recommendation to establish mechanisms to improve Research Technology Transfer. Two actions will support this objective. The Secretary of the Air Force selected a Chief DoD NextGen Architect to assist in capturing requirements and deployment of new technologies. Also, DoD established the Joint Program Office (JPO) to support the NextGen effort through technology transfer for those R&D activities with potential NextGen application. These two actions form the fundamental framework of a mechanism to improve interagency communication between the DoD and FAA for Research Technology Transfer.

Appendix II: Comments from the U.S. Department of Homeland Security

U.S. Department of Homeland Security
Washington, DC 20528



**Homeland
Security**

June 27, 2011

Mr. Gerald L. Dillingham
Director, Physical Infrastructure Issues
U.S. Government Accountability Office
441 G. Street, NW
Washington, DC 20548

Re: Draft Report GAO 11-604, "NEXTGEN AIR TRANSPORTATION SYSTEM:
Mechanisms for Collaboration and Technology Transfer Could be Enhanced to More
Fully Leverage Partner Agency and Industry Resources"

Dear Mr. Dillingham:

Thank you for the opportunity to review and comment on this draft report. The U.S. Department of Homeland Security (DHS) appreciates the U.S. Government Accountability Office's (GAO's) work in planning and conducting its review and issuing this report.

The Department is pleased to note the positive acknowledgement of its role in the area of Next Generation Air Transportation System (NextGen) research and work on the Joint Planning and Implementation Office (JPDO). The Department recognizes the desirability of working closely with other agencies to share technologies to ensure research and development efforts are not duplicated, especially given today's austere budget environment. A number of mechanisms that provide appropriate fora for technology transfer discussions among DHS, the Federal Aviation Administration (FAA), JPDO, and other key stakeholders are in place today.

The most notable mechanism is the newly formed Air Domain Awareness Board (ADAB), which DHS chairs, and in which FAA, JPDO, the U.S. Departments of Defense, Justice, and Commerce; and the Office of the Director of National Intelligence participate. The first meeting of ADAB occurred on May 4, 2011. ADAB supports development of whole-of-government solutions and clarifies priorities for Air Domain Awareness, and synchronizes future interagency actions by identifying overarching investment goals and potential policy/strategic-level synergies, redundancies, and conflicts. It also assigns and monitors tasks and milestones for its subordinate interagency working groups.

A standing working group on integrated air surveillance will be transitioning to the Air Surveillance Working Group under the ADAB. This is the right forum for technology transfer discussions to occur between DHS, FAA, JPDO, and other ADAB participants. DHS Science and Technology Directorate, JPDO, and FAA personnel are all currently active in integrated air surveillance working group meetings. In addition, pursuant to Office of Management and Budget direction, U.S. Customs and Border Protection has been working

with JPDO partners to coordinate among the NextGen partners to develop a strategic Unmanned Aerial System (UAS) research, development, and demonstration interagency roadmap.

The draft report contained one recommendation directed at DHS, with which DHS concurs. Specifically, to more fully leverage the potential of NextGen partner agencies' research and technology development efforts, GAO recommended that the Administrator of the FAA and the Secretaries of Defense and Homeland Security work together to:

Recommendation 1: Develop mechanisms that will enhance technology transfer between the agencies. These mechanisms should focus on improving interagency communication about the specific needs, outcomes, and existing research that FAA has for NextGen, and the existing research and technology development portfolios that may be applicable to NextGen within DOD and DHS. These mechanisms should aim to improve the ability of the agencies to leverage resources or transfer knowledge or technology among each other consistent with the key practices for successful collaboration that we lay out in this report.

Response: Concur. The Department appreciates the desirability for collaboration on this important issue and the development of mechanisms that improve the leverage of resources, knowledge, and/or technology. DHS remains committed to continue working with its interagency partners and other relevant stakeholders to enhance technology transfer between agencies, as appropriate. DHS believes that the newly formed ADAB and its subordinate Air Surveillance working group, together with other efforts focused on specific technology-related issues (such as the UAS partnership discussed above), provide effective mechanisms, as envisioned in GAO's recommendation, for the transfer of NextGen-related technologies among DHS, FAA, JPDO, and other key stakeholders.

Again, thank you for the opportunity to review and comment on this draft report. We look forward to working with you on future Homeland Security issues.

Sincerely,



Jim H. Crumpacker
Director
Departmental GAO/OIG Liaison Office

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Gerald L. Dillingham, Ph.D. (202) 512-2834 or dillingham@gao.gov

Staff Acknowledgments

In addition to the contact named above, individuals making key contributions to this report include Andrew Von Ah (Assistant Director), Richard Hung, Bert Japikse, Delwen Jones, Kieran McCarthy, Josh Ormond, Taylor Reeves, Richard Scott, Maria Stattel, and Jessica Wintfeld.

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